POWER PLANT ENGINEERING

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Electric Power at Oshkosh, Wis.

PLANT DEVELOPMENT FROM PAST EXPERIENCE, PLANNED FOR FUTURE EXTENSIVE DEVELOPMENT, WITH COMPLETE EQUIPMENT OF INSTRUMENTS FOR CONTROL AND RECORDING OF OPERATION. BY T. J. LUCAS

BUILT 20 yr. ago, the old generating station was located on a plot entirely inadequate for future growth; nor were buildings or arrangement of machinery suitable for economical extension. Originally, reciprocating units were used, but these were replaced by two vertical Curtis 500-kw. turbine units and later supplemented by a 500-kw. horizontal Allis-Chalmers Parsons unit. But increase of load finally made it necessary to run all the units at peak load and to operate every boiler at full capacity, a condition obviously not desirable to continue.

Fortunately for the Oshkosh Gas Light Co., which owns the electric system, its president and principal stockholder, Edgar P. Sawyer, owned property adjoining the gas plant large enough to accommodate a good-sized generating station and, as shown on Fig. 1, located on the bank of the Fox River, giving ample feed and condensing water with convenient track facilities for getting coal, and possible future water transportation. There is plenty of room for future extension and for all coal storage likely to be needed. Also the steam end of the plant is able to connect into the operation of the gas plant, supplying steam for water-gas making.

FIG. 9. TURBINE ROOM, SHOWING GENERATING UNITS, SWITCHBOARD PANELS AND BUS AND SWITCH GALLERIES

After careful study of the plant and the distribution system requirements, it was decided in the fall of 1916 to erect a new station on this site, and at the same time to change over the distribution system from 2300-v., 3-phase to 4000-v., 3-phase, 4-wire. No direct current

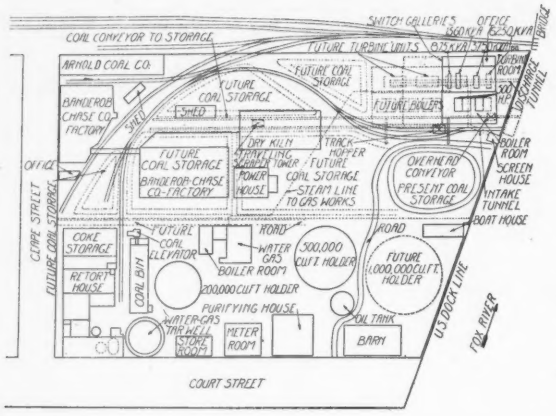


FIG. 1. SITE OF OSHKOSH, WIS., PLANT AND PLANS FOR FUTURE EXTENSIONS

was supplied, as fortunately, this had been eliminated about 4 yr. previously. The company could, therefore, go at once to its ultimate plan of circuit arrangement.

Late in 1916 and early in 1917, orders were placed for the larger equipment and contracts made for the material necessary for the building, a most fortunate circumstance in view of the great war increase in price and demand for such apparatus and materials a little later. Delivery was, of course, hard to get and building was slow; also some changes in plans and design were necessary, as materials contracted for could not be obtained. But work was started late in April, 1917, and went on more or less continuously to completion.

Plant Arrangement

As shown in Fig. 1, the building is located close to the river and to the main line of the Chicago & Northwestern R. R. with room in the present structure for additional machinery, and provision for enlargement by future building and equipment without changing that already completed.

Most of the building site was under water, hence it was necessary to build a pile and timber dock along the river front, and this served as one side of a coffer dam, sheet piling being used to enclose the other three sides of the site. It is planned to cut off the river dock piling eventually and build a reinforced concrete wall along the entire river frontage. This dock and the beginning of the discharge tunnel are shown in Fig. 2, which also shows the spacing of the piling for foundations.

Foundation

These piles, 1500 in number, were of hard wood, driven to refusal, each pile being calculated to carry a

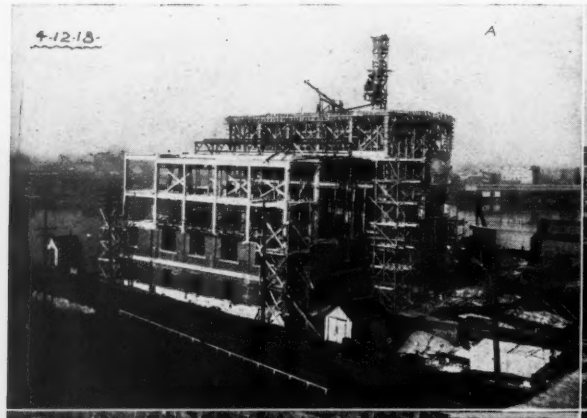


FIG. 6. STATION DURING CONSTRUCTION, TURBINE ROOM SIDE (A)

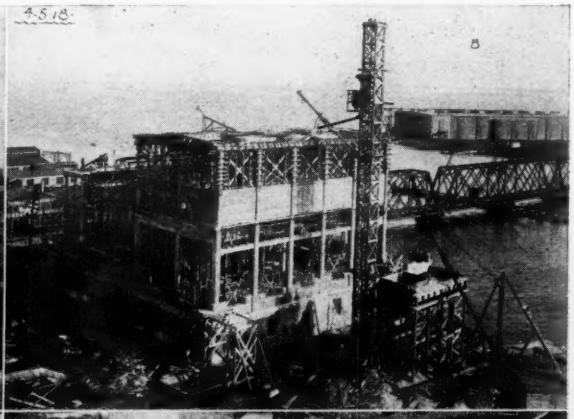


FIG. 7. BOILER ROOM SIDE DURING CONSTRUCTION; SHOWS CONCRETE MIXER AND TOWER (B)

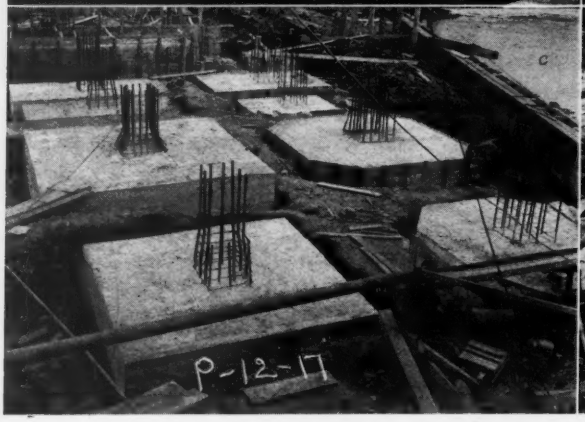


FIG. 5. FOUNDATIONS FOR COLUMN (C)

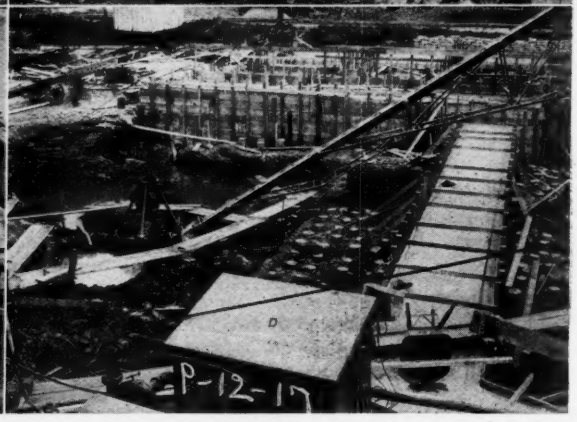


FIG. 2. TIMBER DOCK AND START OF DISCHARGE TUNNEL (D)

load of 24,000 lb. The basement floor was placed 3 ft. above the highest known water in the river, with nothing below that level except the track coal hopper, crusher pits, water softener tank and circulating water tunnels. All but the last were waterproofed with integral waterproofing.

through the boiler settings, the main beams which support the boiler walls and trusses over the turbine room, which are of steel, the entire building framework is a monolith of reinforced concrete. This construction was used for the sake of economy over steel at the time of the building; also the engineers believed that it is a good

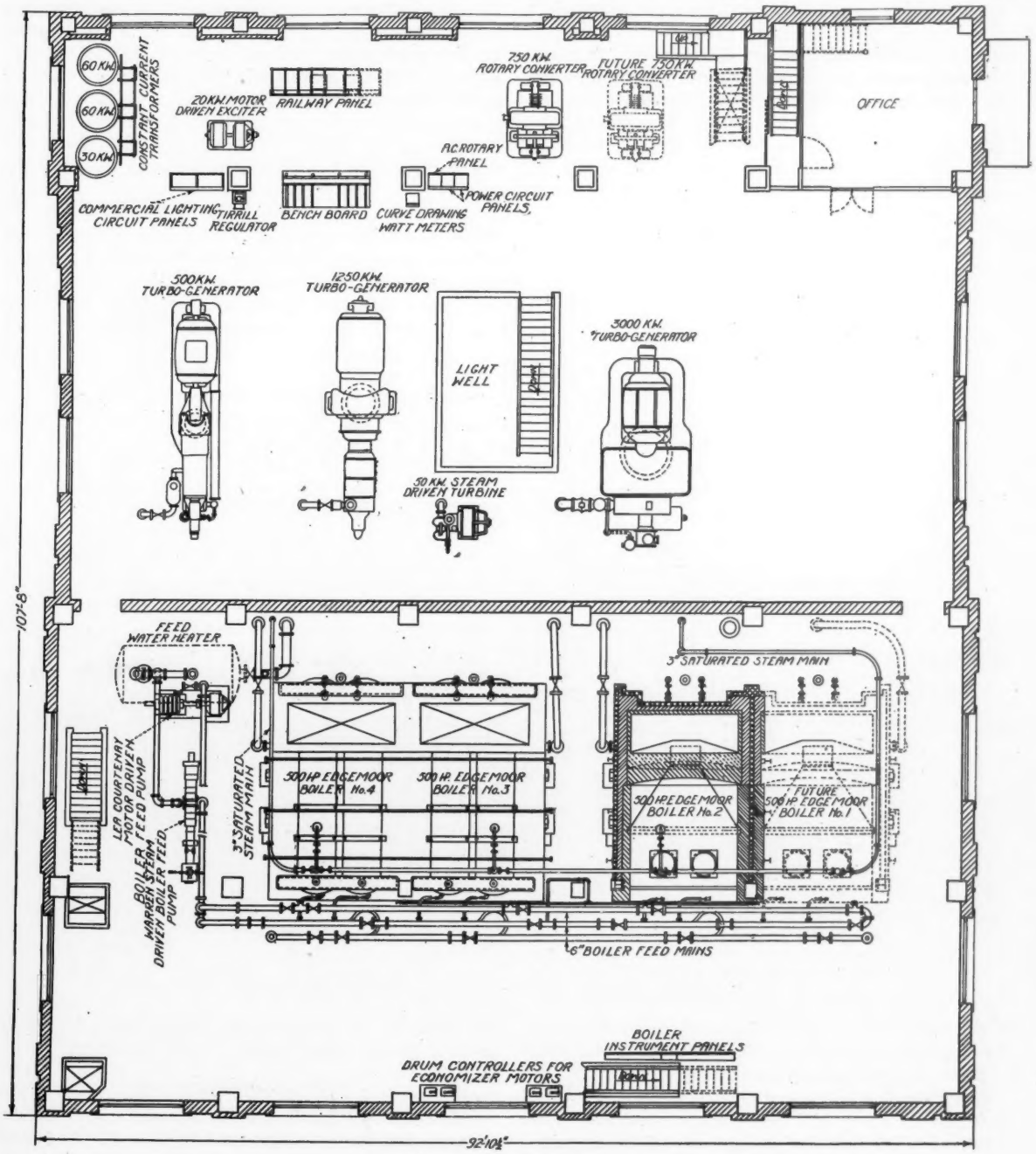


FIG. 3. PLAN OF MAIN FLOOR SHOWING ARRANGEMENT OF BOILER AND TURBINE ROOM

Except where design called for a lower level, the piles were cut off 6 in. above the low water stage of the river and the foundations of concrete laid directly on their heads, which were bedded 6 in. in the concrete.

Building Construction

With the exception of three columns which rise material for building power plants, as it takes heavy loads well and is in itself fireproof.

Arrangement of the columns is shown in Fig. 3, which also shows the plan of the main floor; and the design of foundations, walls, tunnels and roof is shown in this and in Fig. 4. It is seen that the columns are tied into the foundations by the method indicated in Fig. 5; the coal

bunkers, 650-t. capacity, above the boiler room, are built in as part of the structure, while the foundations to carry boilers and generating units are built up independent of the building.

Most of the concrete was placed during freezing weather, but the work went on well and only when extremely cold was it necessary to take precautions other than to heat the water, sand and gravel so that the mixture got to the forms at 100 deg. or warmer. After laying, it was protected by tarpaulins and salamanders for 48 hr. Sand and gravel were heated by steam pipes in room 3-in. gypsum blocks were placed to minimize condensation, and the whole covered with a built-up asbestos roof. Inside finish is of salt glazed brown brick for the boiler room, and in the turbine room a wainscot of white enamel tile up to 6 ft. from the floor, and above a buff iron-spot brick in raised panels between the columns, Fig. 9. This, with the floor painted a medium gray, linoleum runways about the machinery, and steel work an olive green makes an interior fit for the highest type of public building and it is kept in fitting condition for such a use at all times. Light red face brick is used in

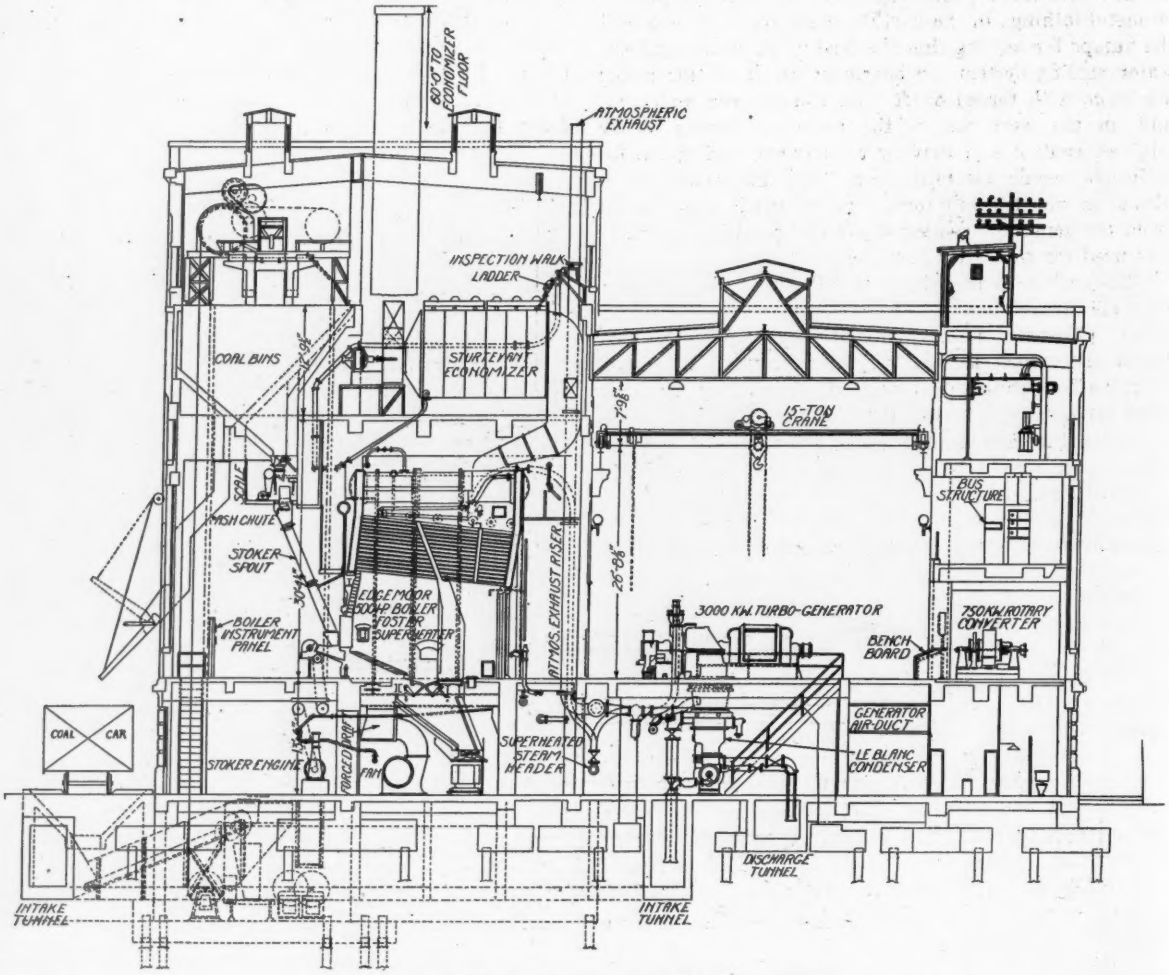


FIG. 4. SECTION OF STATION FROM EAST TO WEST

the sides and bottoms of the bins before feeding to the mixer. The temperature of the concrete mass was tested and salamanders regulated accordingly, snow or ice being cleaned from the forms and steel by steam just before placing the concrete. All concrete was delivered to place by tower and chutes, the arrangement of forms, mixer, tower and chute being shown in Figs. 6 and 7. The start of the brick curtain walls to close in the building is also shown, these being of dark red, iron-spot bricks with a darker trim around the windows, and with sills, water table, copings and cornice of buff Bedford stone. The complete building is shown in Fig. 8.

Doors, window casings and sash are of steel with wired glass, and the roof of concrete. Over the turbine the basement of the turbine room and the machine shop, and for the ash room, common brick, plastered.

General Arrangement

As seen in Figs. 3 and 4, the main floor is divided into the boiler room which contains also the feed-water heater, boiler feed pumps and boiler gage board; and the turbine room which has on the east side the chief engineer's office, control boards, exciter, railway converter, and above the switch galleries. This floor is 15 ft. above that of the basement, and is of concrete slabs between reinforced concrete girders. Over the firing aisle are the coal bunkers, with an ash bunker at the north end, and above the boilers is the economizer floor,

which carries also the induced draft fans and the steel stacks rising 60 ft. above this floor. In the basement are stoker engines, forced draft fans, ash disposal, pumps and water softener, and at the north end a pivoted bucket elevator extends from the coal hopper at sub-basement level to above the bunkers.

In the boiler room roof are monitors, one above the coal bunkers, the other above the economizers. These compartments are separated by a solid wall, running clear to the roof, so that dust from coal handling is confined to the place where it is made. The basement is divided into three parts, separated by walls of plaster on metal lathing; in the north end are treating tank and the pumps for serving this, the feed water heater and the water cooling system for bearings; south of this is the ash room with forced draft fans, ash hoppers and cars; and on the west side is the room containing stoker engines, control and driving mechanism, and space for a future repair machine shop. The ash room serves also as an air reservoir for the forced draft fans, hot air from the generator cooling ducts being discharged there and used for the boiler furnaces.

The turbine room, Fig. 9, is full height with a craneway and turret above and condensers in the basement below. Transformers, private and general toilets are below the switch section, the entrance hall below the chief's office, while a pent house on the roof houses lightning arresters and outlets for cables.

Below the basement are the intake and discharge tunnels as seen on Fig. 4, the former having its inlet from a branch leading under the boiler room basement to a screen house upstream on the river bank, Fig. 10. The intake is designed for a maximum velocity at the screen house of 5.25 ft. per sec. at lowest water level for a capacity of 30,000 kw. The discharge tunnel is at a higher level to reduce excavation and concrete, and discharges direct to the river, a gate being placed just inside the basement wall to regulate the water level, so as to insure a seal on condenser discharge pipes at all times. This can be raised to allow washing off the floor of the tunnel. At the entrance to the intake, the screen house has two compartments, each containing a trash rack and three stationary screens, room for a traveling screen being provided, when such equipment becomes necessary. Allowance is made for accumulation of 2 ft. of mud in the intake without interfering with the operation, and provision is made for cleaning without interfering with operation of the plant.

Details of Boiler Room.

Three horizontal, water-tube boilers, rated at 500 hp. each, are installed, with room for a fourth in the present building, set two in battery. These are intended to run at 180 per cent of rating under normal operation, and up to 275 per cent of rating for peak loads or emergency. Each battery has a forced draft fan, turbine driven through reducing gears and discharging into a pressure chamber beneath the boilers, and an economizer above with motor driven induced draft fan, having dampers arranged to bypass the economizer when necessary. The forced draft fan speed is controlled by regulators on the steam inlet to the fan turbine, this in turn being controlled by boiler pressure, and the air pressure to each stoker regulated by dampers. Speed of the induced draft fans is controlled from the boiler room floor by controller handles operating resistances in the basement.

Main air ducts are of cement plaster on metal lath, and branches are of galvanized iron, auxiliary ducts being provided to carry air over the steel beams supporting the boiler walls, thus cooling them and preventing warping. Air supply to the ash room where the forced draft fans are located is from the cooling ducts of the generators, or through openings in the outside wall, fitted with louvres which can be closed down as much as desired.

Each boiler is provided with a superheater, as shown in Fig. 4, and with a built-in soot blower for cleaning tubes. The water legs are set at 12 ft. from the floor of the boiler room, having special arches to carry the front furnace wall. Nine inch fire brick is used for

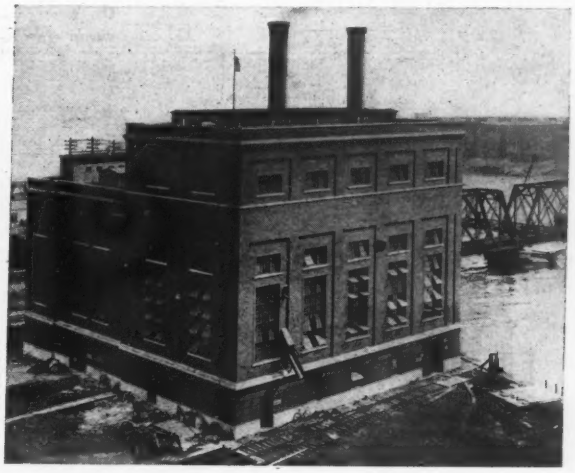


FIG. 8. COMPLETED STATION FROM BOILER ROOM SIDE

furnace lining up to the tube level and 4½-in. fire brick above the tubes and to line the combustion chamber. The entire front stoker wall is of fire brick above the special arch, as well as the bridge wall except for a small core of common brick. The balance of the setting is of common brick. The entire outside is covered with 4½-in. insulating brick, and outside of this is placed metal lath covered with 1 in. of asbestos plaster. For an outside finish, the whole setting is covered with 8-oz. canvas and painted with two coats of lead and oil paint.

Coal and Ash Handling.

From the switch track at the west of the boiler room, Fig. 8, coal is dumped into the hopper shown dotted in Fig. 4, below basement level and carried by a belt conveyor to the bucket elevator, which carries it to the level above the bunkers where it is delivered by a steel chute to a belt conveyor running lengthwise of the bunker. This has a self propelling and self reversing tripper to deliver to any part of the bunker, the capacity of the system being 60 t. an hour and of the bunker 650 t.

As indicated on Fig. 1, future arrangement is planned, in case lake transportation becomes a factor for a fast tower on the roof near the dock to take coal from barges and deliver to a crusher on the roof, thence to the belt conveyor, which is reversible, for delivery to the

bunkers or to the storage yard. Reclaiming will be by scraper or locomotive crane into the track hopper.

Ashes fall from the stokers into hoppers which deliver to push cars in the basement. At present, all ashes are taken into the yard and are carted away by contractors for filling, but they can be fed through a floor hopper and a reciprocating feeder to the bucket elevator, which will carry them to an overhead bin, whence they go by steel chute and counterweighted apron shown in Fig. 8, to wagons or cars on the switch track.

Eventually, it will be necessary to switch cars across the track hopper by cable haul and space for the winding machinery has been allowed in the hopper pit.

From the bunker, coal falls by gravity through

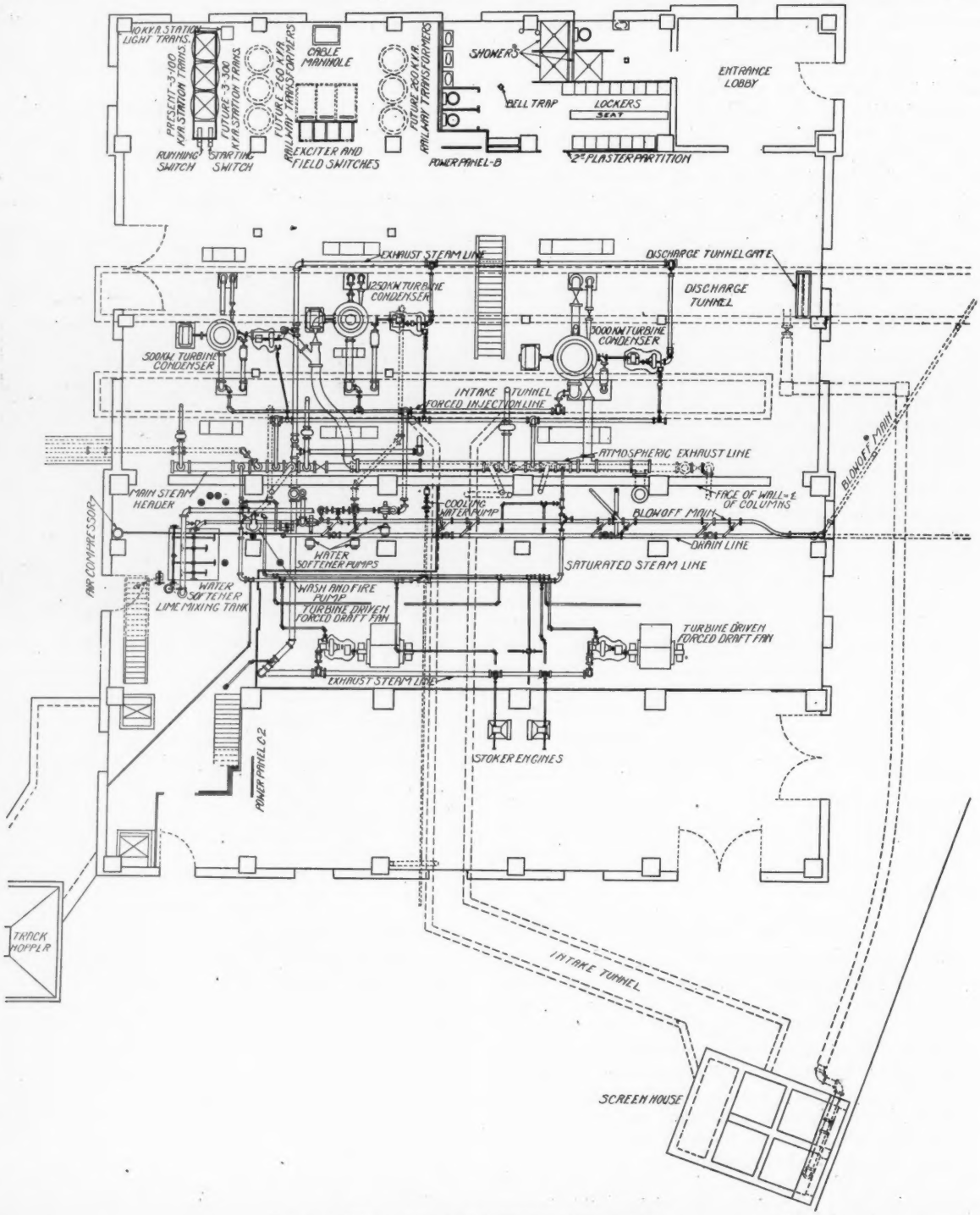


FIG. 10. PLAN OF BASEMENT AND PIPING

undercut gates into automatic scales, to which it is fed by motor-driven worm, filling a weighing tipping hopper which records the number of dumps made. Spouts from the scales lead to the stoker hoppers which are inclosed, so that no coal dust gets into the boiler room. Feed through the scales is controlled from either of two switches, one at the scales, the other at the stoker hopper. The arrangement is well shown in Fig. 11.

Water Handling.

Feed water is taken from the discharge tunnel by either of two motor-driven centrifugal pumps which deliver to the water softener, located in the basement, Fig. 10, and from the softener passes through a sand filter to a storage well beneath the basement. The water is then lifted by a centrifugal pump, or by a reciprocating pump which is a general utility apparatus, to an open feed-water heater on a gallery at the level of the boiler tops. This general purpose reciprocating pump is so connected that it may take water either from the softener storage basin, or from the discharge tunnel; and it may deliver either to the feed-water heater or direct to a feed-water main running along the boiler fronts near the top. Connection is also made to a washout line for cleaning boilers and feed-water heater and to a priming line for centrifugals.

Supply to the feed-water heater is from the pumps mentioned. This heater has outlets to the station supply and boiler feed pumps, and blow downs to a drain pipe for both water and sediment. Boiler feed is by either a 5-stage centrifugal pump, motor driven, or a reciprocating outside packed plunger pump, each feeding into either one of a pair of 6-in. feed mains which form a loop, Fig. 3. From the inner of these mains connections lead to the economizers, the hot water being returned to a third main which is joined by a goose-neck at each boiler to the feed inlet. Valves are installed so that any combination of feed may be obtained in emergency, from soft water basin, from feed-water heater or from the discharge tunnel.

Drive of auxiliaries is so designed for motors, turbines, or, as in the case of the condenser removal pumps, both, that the steam available at all times will be sufficient to heat the feedwater to 150 deg. without waste of heat, and this temperature is maintained for water going to the economizer thus preventing sweating of economizer tubes with its consequent formation of sulphurous acid and pitting of tubes. Economizer surface is sufficient with inlet temperature of 150 deg. F. to give a feed temperature of 250 to 260 deg. F. going to the boilers.

Water softening is by the cold process lime and soda ash treatment, the maximum filtering capacity being 12,000 gal. per hr. This can be doubled by extending the filter and settling tank to the north outside the building.

Nearly all machine bearings in the plant are water-cooled, and to supply this system as well as the turbine oil cooling coils a small pump is provided taking water from a 5-in. well, 200 ft. deep. High pressure water is also provided to the condenser heads for use in getting vacuum when starting up the generating units.

Steam Supply.

Boiler pressure is carried at 225 lb. with superheat to 550 deg. the steam being taken from the superheaters through long radius boiler branches running down along the boiler room wall to a main located in the turbine room basement and shown in Figs. 4 and 10. This header is carried on roller bearings resting on concrete piers, and is connected by long sweep bends at either end to an auxiliary header from which supply is taken to turbines driving the condenser pumps and steam-driven exciter. Generator turbines are supplied by connection direct to the main header. Connection is also made from the main header through a reducing valve to the saturated steam header which supplies boiler from auxiliaries; but this connection is used only in case of emergency, as the superheated steam is not suited for the reciprocating pumps and stoker engines. From the north end of the main steam header, a line leads through a concrete conduit to the gas works where pressure is reduced to 100 lb. with a safety valve on the low pressure side.

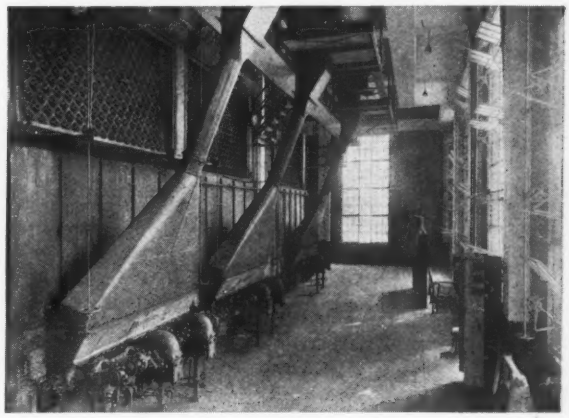


FIG. 11. FIRING AISLE IN BOILER ROOM; SHOWS BOILER FRONTS, COAL SCALES AT TOP, BOILER GAGE BOARD AT RIGHT

Saturated steam is taken from 2-in. nozzles at the front end of steam drums of the boilers to a 3-in. header which runs above the boilers, then loops back at either end and down to the basement where pressure is reduced to 175 lb. and the line looped, Fig. 10. From this, branches are taken to the forced draft fan turbines; stoker engines, general purpose feed pump, boiler feed pumps, and air compressor. This line is protected by a safety valve set at 175 lb.

Steam for the soot blowers is taken from the superheated system to keep down condensation on the boiler tubes and reduce possible pitting from formation of nascent sulphurous acid.

Connections from boilers to both superheated and saturated steam headers are provided with gate shutoff valves and nonreturn valves located at the highest point of the line. On the superheated lines cast steel valves and fittings are used with cranelap flanges, and long bends are substituted for fittings wherever possible. On the saturated line, extra heavy iron gate valves and cast-iron fittings with screwed ends are used.

Exhaust lines are of usual construction, that for atmospheric exhaust of the generating units being in

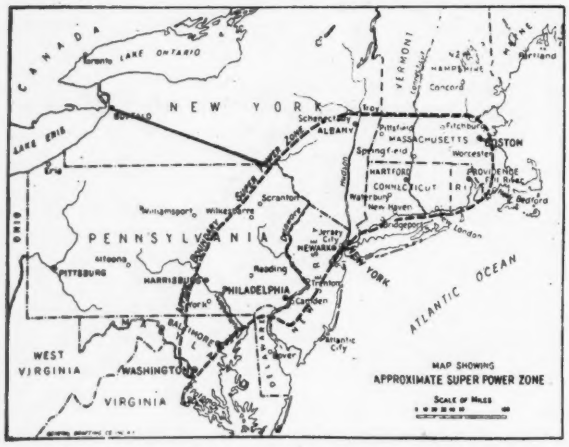
(Continued on page 1186)

Super-Power Districts

ADVANTAGES CLAIMED. OUTLINE OF FIRST DISTRICT. ORGANIZATION FOR SURVEY. LOCATION OF SUPER-POWER DISTRICT AS PROPOSED. BY W. BENJAMIN WEST

INTERCONNECTION of power plants has been largely practiced for many years in a limited way in the eastern and central sections of the country and over wide areas in the west. It has been a means of swapping power between plants in case of accident, of evening up load on the various stations and of utilizing extra power of streams during the flood season and helping out from steam stations during low water.

Extension of this practice is now proposed on a huge scale with the object of generating power in steam plants of a size that can operate at highest economy, placing many of these at the mine mouth, thus doing away with hauling of coal, and tying in with hydroelectric plants so as to use all the water power available, calling on the steam plants only for that which the water powers cannot supply.



PROPOSED BOSTON-WASHINGTON SUPER-POWER DISTRICT

It is proposed that the first district shall cover the area from Boston, Mass., to Washington, D. C., extending 150 mi. inland, and having a feeder line connecting in from Niagara Falls, as shown in the map.

The proposal that a super-power zone be created in the section of the Atlantic seaboard lying between Boston and Washington and extending 100 to 150 mi. inland calls for the electrification of the railroads and industries in this congested district and for the installation of a comparatively few especially large electric generating stations of the most modern type to furnish the necessary power. The plan was discussed at the midwinter convention of the A. I. E. E. in New York, Feb. 19, 1920. Symposiums were contributed by Messrs. W. L. R. Emmet, J. F. Johnson, H. G. Reist, F. D. Newbury, W. B. Potter, P. Torchio, P. H. Thomas, W. D. A. Peaslee, and A. O. Austin, all experts in their respective fields. Under the leadership of W. S. Murray, chairman of the Traction and Transportation Committee, truly astonishing facts were brought out. For example, the electrification of this district would raise the load-factor from 15 up to 50 or possibly 60 per cent, would enable one ton of coal to do the work of two and would produce a 25 per cent saving annually on the total investment cost.

Based upon the recommendation of a committee of electrical engineers and former Secretary of the Interior Franklin K. Lane, Congress appropriated the sum of $125,000 for the investigation of the project. Mr. Murray having been the originator of the idea was naturally appointed chairman of the committee which is authorized to carry out the work.

By future development of water power, and the location of large steam-driven electric stations at tidewater and at points near the mouth of mines it is estimated that the present power requirements could be served by one-third of the present generating capacity. It is of national importance also that by such a co-ordinated power arrangement not less than 30,000,000 tons of coal, the equivalent of $150,000,000, will be saved annually, besides decreasing in almost equal amount the annual expense of maintaining inadequate power machinery now in operation. In order to carry out properly the multitudinous details of the investigation, the Super-Power Survey has been organized into three departments of investigation: (1) railways, (2) industries, and (3) power and transmission. The chairman has appointed as respective heads of these departments Cary T. Hutchinson, Henry W. Butler, L. E. Imlay; Henry Flood, Jr., has been appointed engineer-secretary.

Mr. Flood has sent out 450 letters to the government and public service commissions and to executives of railways and the central stations in the states which the super-power zone includes and their insistent and favorable responses gave indication of their interest and desire to help in every possible way to furnish the necessary data.

Mr. Murray, in discussing the plan, states that in the area mentioned, which is 2 per cent of that of the United States, the industries use 10,000,000 hp. and the railroads, 7,000,000 hp., a total of 17,000,000.

By the installation of high-powered, high-economy tidewater steam and hydroelectric stations and steam stations located at the mouth of mines, within the territory named, all interconnected with a transmission system, using also the large central stations now built and located at the larger cities, such as in Boston, Providence, New York, Philadelphia, and Baltimore, there can be integrated one great regional power system from which power can be delivered to the industries and railroads.

There will be created a common carrier system of power, lifting the coal off the rails and automatically opening up cargo space for the haul of more valuable and higher-priced commodities. Operation will be speeded up in large switching yards and passenger terminals, thus increasing track capacity without adding track mileage or equipment due to the greater facility of control in the three classes of service—passenger, freight, and switch.

The coal saved will reduce the labor of the miner, the maintenance of the tools he used in mining, the maintenance of and cost of operating the equipment that hauled the ton of coal. While we are throwing away one ton of every two taken out of the ground, the hole

is getting deeper, the lift is getting more costly and we are exhausting the great eastern coal fields. Except for those who are too blind to see, this can mean but one thing—namely, that the cost of coal is on the upgrade and there is no summit to the grade. But we can at least lower percentage of that grade.

That this project has the hearty support of the business-thinking people of the country is evidenced by the concordant action of many chambers of commerce within the zone named, their unanimous indorsement following each presentation of the subject.

The very simplicity of the super-power system robs it of the terrors of its size. I have a very great belief in and respect for the American engineer and business man; and, once knowing that there is actually going to waste $300,000,000 a year, he will not stop short of saving that amount if a system can be constructed which, while the interest, insurance, depreciation and taxes are in proper relation to the investment, makes so tremendously for the conservation of our natural resources.

It is quite natural that something that can save so large a sum of money must be large in itself. The investigation and report would not be complete without the inclusion of a plan looking toward the financing of the project, and such a course of procedure should be outlined quite as definitely as the system which will eliminate these wastes. I believe, however, it is far more important first to allocate these wastes and their amount so that when equated in dollars and cents, they will form a solid foundation upon which to base financing. The part, therefore, that the Government is playing in this matter is only to finance an administrative and engineering force to show clearly what these wastes are; and this force has been organized and is known as the Super-Power Survey, with headquarters at 709 Sixth Avenue, New York City.

The zone described is the most congested railroad and industrial district in the United States but there are others that are due for investigation of a similar character. In short, it may be said that the project makes toward the establishment of a national power policy, and the other districts will be electrified in the order of their power density. Both Mr. Good and Mr. Bryan, neither of whom lives in the region under consideration, gave full evidence of the broadness of their vision in assigning a national aspect to the matter, and already this same attitude has been accorded the engineering staff assigned to undertake the investigation and report; and as every man who lives within the zone described is taxed for this waste he will necessarily co-operate to the end that the report may be of value to both the nation and to himself.

Should the findings of the Super-Power Survey show that the plan is feasible and will justify the expenditure of money for the construction of such a system, the public will begin to awaken to the possibilities and advantages of hydroelectric development and the electrification of our railroads, together with the inter-connection of electrical power transmission lines all over the country. The awakened public interest in water-power development and electrification will react upon capital and in turn our law-making bodies so that one can fairly see upon the horizon a real hydroelectric development era.

A Fireman's Experience with Pulverized Coal

General Description of Plant Equipment and Difficulties Which Are Met by the Operating Force. By M. S. Howard

CONSIDERABLE attention is being given to pulverized coal as a boiler fuel. In the main, most of the information so far published has come from the technical engineer. Too frequently the articles deal entirely with matters of general design, giving but minor mention, if any at all, to the problems of actual operation of pulverizing plants and the methods to be followed to secure success in firing the fuel.

To the informed, it is well known that no matter how advantageous a process may be from the theoretical standpoint, it will fail miserably if the man who is actually in charge of the operation does not understand the practical side of it.

With the intention of outlining the procedure necessary for the fireman to follow, the writer ventures to describe briefly the methods followed in a boiler plant where pulverized coal is now used.

General Advantages of Pulverized Coal

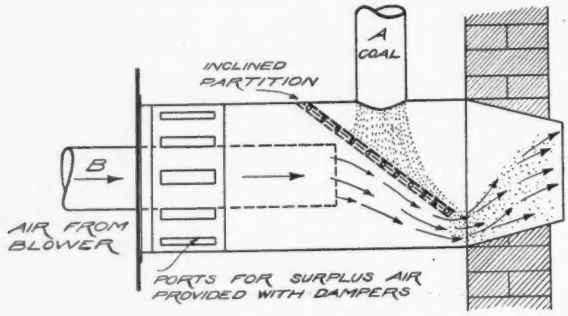
THE REASON for pulverizing or powdering coal is the fact that even with the highest grade coal, it is difficult to bring the necessary amount of air into contact with each particle of carbon in the coal. With coal, both lump and slack, the combustible particles on the outside must unite with the oxygen in the air before those particles in the interior of the coal lumps can come into contact with the air. This results in part of the coal being supplied with an insufficient amount of air, producing low CO_2 and high CO. Furthermore, the impurities in the coal tend to form clinkers and slag, reducing the process of combustion. Even with the use of stokers, the efficiency of the furnace is not as good as it should be. To provide oxygen for combustion, since usually an insufficient amount passes up through the coal, large amounts are admitted over the fire. This undoubtedly chills the boiler shell.

It is probable that the first plan of pulverizing coal was due to the results attained by the use of fuel oil. With oil, when thoroughly atomized, each minute particle of oil comes in contact with the necessary amount of air. Increased efficiency is obtained solely by the better mixture of air and carbon in the oil. The advantage, then, of using pulverized coal lies in the more perfect air and carbon mixture and in the freedom from clinkering on the grates. In securing this increased efficiency, certain operating difficulties appear which must not be forgotten. The writer, though, is firm in the belief that under proper conditions pulverized coal makes firing easier, efficiency higher and the total cost per pound of water evaporated lower. Furthermore, lower grades of fuel can be burned, since trouble from clinkering or slagging of grates is eliminated by the absence of all grates.

Plant Equipment

The pulverized coal plant in question was installed 5 yr. ago. After being in operation for some little time, it was discontinued, since natural gas and, subsequently, fuel oil was cheaper than coal. At present, due to the decrease of natural gas and the high price of oil, the pulverized coal equipment is again in use.

In handling the fuel, the coal is dumped from the cars onto an inclined conveyor belt which elevates it to the hopper of a crusher. The crusher reduces the coal to about the size of the usual slack or buckwheat. It is then elevated and dropped into the end of a revolving drum or drier. The drier is enclosed in a brick setting and is heated by a coal fire. After being dried so that not more than 2 per cent moisture is left, the coal is conveyed to a ball mill. This is a rapidly revolving basket containing chilled cast-iron balls. The coal is so pulverized that 95 per cent will pass through a 100 mesh screen and 75 per cent through a 200 mesh screen. The pulverized coal is conveyed and deposited in overhead bins in the boiler room. A small screw conveyor in the bottom of the bin forces the coal into a pipe which drops vertically downward into the burner. This furnace appears as shown in the illustration where A is the coal



PULVERIZED COAL BURNER

pipe and B is the air-blast pipe. The air, as it blows under the partition, picks up the stream of coal dust and injects it into the boiler furnace.

Drying and Moisture Troubles

In operation, the boiler-room force encountered a number of difficulties. Some of these have been overcome; none are insurmountable or as great as with a stoker equipment. The coal, as it is dumped out of the cars onto the conveyor, often comes in slugs. The drier, then, at times has so much coal going through it that a lot of moisture is left in the coal. This moisture clogs up the ball mill or pulverizer. As this water-logged coal dust passes into the bins, it tends to hang in masses and will not feed regularly to the screw conveyor at the bottom.

On the other hand, since the coal comes out of the dump cars irregularly, at times the drier has only a little stream of coal passing through it. The heat of the drier is so great that the coal is not only dried but oftentimes is ignited. If a spark is carried over into the ball mill, a fire at once starts and is hard to put out. Sometimes the spark passes into the overhead coal bins. Here it will smolder away and often burst into flames. The burning mass of coal works down into the bottom of the bin and chokes the conveyor. The coal when ignited often becomes a pasty mass that clogs up the conveyor blades. To remove the burning coal, it is necessary to go on top of the bin and, removing the cover, pull out the mass with a hook. It is by no means a pleasant job to do this.

Trouble has also been experienced with the drier fire box. The drier has grate bars and is hand-fired. It is almost impossible to maintain an even furnace temperature. The variation in the drier furnace likewise affects the amount of moisture removed from the coal passing through the furnace. It is planned to use pulverized coal in the drier furnace. The temperature can then be kept constant.

The most important improvement that can be made is some arrangement whereby a constant stream of coal can be passed through the drier. If this is done, and it is by no means impossible, practically all fires could be avoided. Some system of coal weighing could be used so that a set amount of coal could be deposited onto the conveyor belt every minute. At present it is necessary to have a man stationed at the conveyor to shovel on a steady stream of coal.

A magnet at the top of the conveyor catches most of the steel and iron pieces in the coal. Once in a while a piece gets by and breaks a tooth in the crusher. This could be avoided by making the conveyor wider so that every piece passing along the belt touches the magnet bar.

The pulverizer or ball mill is very dusty, and the dust is hard on a man's lungs. A better arrangement is needed here, as it is hard to keep a man on this job. The balls in the mill, which are about 9 in. in diameter, last about three months.

Where a plant uses storage coal, lots of dirt is picked up with the coal. The dirt chokes up the screw conveyor. We put in a conveyor with a shallower screw and finer pitch and the trouble was almost stopped.

Bins Clog

When put in, the bins were pyramid in shape. The coal dust settled in the corners and caught fire from spontaneous combustion. At other times when the coal bin would be almost empty, the masses of coal in the corners would drop down to the bottom, slugging the conveyor and feeding too fast to the burners. Plates were put in the bins at each corner so that the coal could not hang there. Also, even with rounded corners, at times the coal in the bottom feeds out leaving the rest of the coal untouched. It is then necessary to poke the coal from the top to break it up and start it flowing to the bottom. All coal-dust bins should have round corners, and the sides should flare from the bottom at about 60 deg. pitch to avoid any packing of the fuel.

Burners and Furnaces

There are six water-tube boilers of 265 hp. each. There are two kinds of burners used, while two of the boilers still have the oil burners in.

The burner first used was not quite like that shown in the illustration but was altered several times until the design shown here was built. It works better than any of the others. The second type has the coal entering the furnace at the top of the dutch-oven arch. The coal dust, if fed heavy, often drops down into the bottom of the furnace and slags.

The burner shown here is placed in the front of the furnace; the coal dust drops down in a steady stream

onto the sloping plate; the air from the blower enters at B and passes under the plate. The coal dust is blown into the furnace and is well mixed with the air before it ignites.

The air blower and the coal screw conveyor are driven by a motor which can have its speed changed. If the steam pressure drops, the motor is speeded up and the coal and air supply is increased. If the fire is forced too much, not all the coal will burn. Part drops down into the bottom of the furnace, which is 6 ft. below the floor line. Here the coal burns and slags. It is a hard job to break up this slag and get it out, and this is the real difficulty in burning coal dust.

If the furnaces were made larger, the boilers could be forced more. Larger furnaces never slag as much as do the small ones. The fire is not as hard on the fire-brick lining as is the fuel-oil flame. The bricks glaze over, and since no clinkers form along the sides, no bricks are broken in hooking. In these boilers the bricks which were put in 5 yr. ago are still good.

A lot of fine ashes settle on the boiler tubes. It requires more tube blowing than natural gas or oil does. A lot also settles in the combustion chamber; about 20 per cent of the coal fired is hauled out of the combustion chamber as ashes; however, the coal is very bad, having a large percentage of impurities.

The plant is not very close to any but the company's own buildings, and so there is no complaint about the fine ashes blowing out of the stack. This dust settles on the roofs, but to offset the dust only a little smoke is produced.

It requires more men to handle the boiler room and pulverizing plant than would a stoker plant. If the lay-out were better planned, two men could be cut off the pay roll. The work in the pulverizing plant is dirty and dusty, but in the boiler room everything is clean and there is little dust. It is easier on the fireman than hand firing or stokers, and no more work is needed than in an oil-burning plant.

The Fallacy of Superheating Exhaust Steam*

By W. F. Schaphorst

THE superheating of exhaust steam has frequently been advocated. It sounds well, and on the surface appears to be an economical method. There is, however, a "nigger in the woodpile," which it might be well to discuss in the pages of this publication. I will endeavor to point out in a simple way the impracticability and uselessness of this method.

Assume a steam coil located in a room, chamber or body which is to be heated to a temperature of 250 deg. F.

Now, the temperature of exhaust steam is 212 deg. F. so an engineer approaches the owner and says: "Why not heat your exhaust steam from 212 deg. F. to 260 deg. F.—a difference of 48 deg. F.—and you can easily obtain the 250 deg. temperature desired in the chamber?"

This looks alluring to the owner, who does not know anything about the physical properties of steam, and he says to the engineer without further thought: "Go ahead and have the superheater put in. That sounds like a very good, logical, cheap way to do it."

The superheater is installed; the exhaust steam is passed through the superheater and is superheated to the temperature of 260 deg. The arrangement works very nicely for a while until a certain temperature is reached in the chamber, but after that it is discovered that something is wrong. For some reason or other, the superheater doesn't work.

What is the matter? The explanation is this: Exhaust steam at atmospheric pressure will not condense unless the temperature surrounding it is less than 212 deg. F. Just as soon as the temperature in the chamber is higher than 212 deg. F. it becomes impossible for the steam to condense. Hence, the steam coils simply fill up with steam and the steam remains there as long as the temperature is higher than the temperature corresponding to atmospheric pressure which is 212 deg. F. Therefore, it is virtually impossible to attain a higher temperature in the chamber than 212 deg. F.

Ordinarily, without superheating, to attain a temperature of 260 deg. in the steam coils, a gage pressure of 21 lb. per sq. in. is necessary. Then, as long as the temperature in the surrounding chamber is less than 260 deg. the steam within the coils will condense and it can be trapped out easily. Hence, with saturated steam no difficulty is experienced in maintaining a temperature of 260 deg. F. in the chamber as long as the heating surface is efficient.

Where the superheated steam can be kept in motion and passed through the steam coils, the exhaust from the coils or from the chamber being used for heating or other purposes, it might be profitable to attach superheaters, but this is a point that should be looked into carefully before any steps are taken, since it can be proved that in many instances a superheater is simply superfluous equipment that should not be used at all. It does not produce any gain in the steam economy, but rather adds a burden in first cost.

Rather than superheat the exhaust steam where it is primarily a problem of attaining a certain high temperature, it is frequently more economical simply to apply a naked flame or to apply high pressure steam directly to the heating surface of the chamber.

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THE REFERENDUM on the erection and operation of a municipally owned and operated heat, light and power plant for Newark, N. J., was carried there by a vote of 35,814 against 34,165. The proposal was bitterly opposed by the Chamber of Commerce, which circularized many voters. The proposal to have a municipal power plant was first introduced 10 yr. ago by Mayor Charles P. Gillen, then a member of the Board of Works. Thomas L. Raymond, Commissioner of Public Works, is expected to have plans drawn for the proposed triple plant. It has been suggested that the city derive some of its power from the watershed near Pompton.

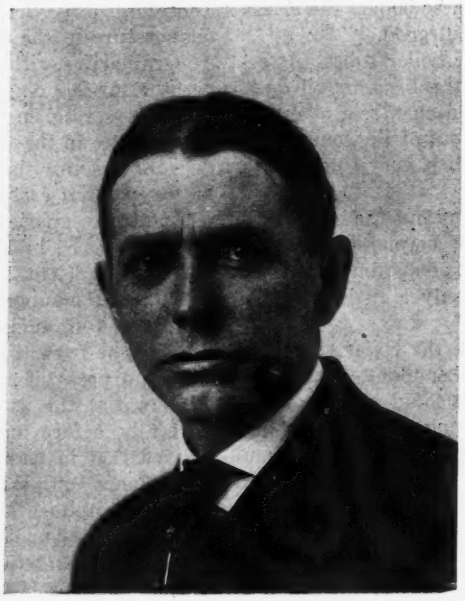
NEW YORK EDISON CO. has prepared plans for the erection of a new power house on Locust Ave., Bronx, between 132d and 134th Sts. and East River. The building is to cost $5,500,000 and will be of brick and steel construction.

ALEXANDER D. BAILEY

WHILE CLIMBING STEADILY TO THE TOP HE EXTENDS A HELPING HAND AND WORD OF CHEER TO ALL WHO WOULD FOLLOW. BY ERNEST S. BUTT.

IT USED to be the fashion among writing men to pen the biography of a successful man after he had passed, probably because the subject of the sketch then had no chance to contradict the author and for the reason that a man's good works never become known until the biographer puts them together for publication. The influence of a likable personality never dies; indeed it is felt long after his very name has been forgotten. The result of his labor is still with us, but his soul goes marching on.

But it seems that times have changed. The point of view now is gaged from a different angle. Twentieth century ideas demand twentieth century methods for expression. Hence, we will talk about a man who "is," instead of a man who "was."



Alexander Davidson Bailey is by choice, training, and natural aptitude an electrical engineer. Furthermore he is an American —by birth. Salem, a small town in a Wisconsin farming community, is his birthplace, and Feb. 14, 1882, the date of his advent. When he was interviewed for material from which to construct this article, he told the interviewer he bore the same first name as the "Great" and the same middle name as John D. Rockefeller. "But there," he added, "the similarity ends." Then he concluded: "one humorously inclined might make a joke of my life, but I have to take it seriously—it is the only one I have."

The statement was made in a preceding paragraph that "Alec" Bailey is endowed with a "likable personality." Just how to define so chimerical a thing as a "likable personality" is obviously difficult. But the reader can glean some idea of the personality of the subject of this sketch when it is said that he is as much at home in a suit of overalls as he is in evening dress. That is why he is known to practically all his intimates as well as his subordinates as "Alec."

When Alexander Bailey was seven years old, his parents moved to Chicago. The family settled on the cosmopolitan West Side and the future engineer attended the public school. After graduation, he spent four years in high school at Glen Ellyn, a suburb of Chicago, and graduated four years later. But during his last year, he found it necessary to obtain employment during the day, which he did as draftsman for a wind engine and pump concern in Batavia, another suburb of Chicago. After graduation from Lewis with an M.E. degree, he was employed by the Evanston Heating Company and discovered—as he put it—"that there is no use arguing with a man or woman if their feet are cold." So he entered the service of the Chicago Edison Company late in the year 1903.

He was first assigned to the Harrison Street Station, at that time the last word in central stations in this country, if not in the world. His days were spent in practicing his profession at Harrison Street Station; his evenings as instructor at Lewis—his Alma Mater. Evidently the faculty recognized ability in the graduates, for Bailey remained at Lewis, as instructor in the night school, for five years.

After three years at Harrison Street, Bailey was assigned to the Engineering Department of the Edison Company. He remained there for two years planning general engineering work and was sent to the Fisk Street Station, the successor to Harrison Street as the biggest and most modern central station here or anywhere. He went to Fisk Street in 1906, becoming Assistant Chief Engineer and—a little later—Chief Engineer, the position he now holds, except that Fisk and Quarry Street Stations are combined and represent the source of the greatest output of electricity that exists. So ends the purely biographical data.

Like every other successful man, Alec Bailey has a hobby—in this case, two of them. First, he likes to disseminate information to beginners in his profession. Second, he has a penchant for golf. Reverting to the first hobby, Bailey's wide and varied experience in central station and engineering practice has made him a recognized authority on those branches of industry. Conse-

quently, he has delivered a great number of lectures and written many papers on these subjects. He is chairman of the Student Branches Committee, Western Society of Engineers; and holds important executive posts in the American Society of Mechanical Engineers, as well as the National Electric Light Association. He is also a charter member of the Edison Club. Of his golf, one can say that if he was as good a golfer as he is an engineer, Evans, Gardner, or Hagen wouldn't be as famous as they now are.

As has been stated, there is nothing more elusive, more difficult of accurate definition than personality. You may say of this man or that man that he has magnetism, force of character, or qualities of leadership, but adequately to portray these qualities in words is a difficult task. The subject of this sketch is happily endowed with one of those delightful and engaging personalities which in many respects is strongly suggestive of the endearing characteristics that distinguished Robert Louis Stevenson *the man* as entirely apart from Robert Louis Stevenson the celebrated litterateur. Occasionally you meet men who possess this rare quality, which has in it something of boyishness, of whimsical humor and of charming *camaraderie*, and when you have the good fortune to meet such a man, your heart instinctively warms to him even as it warms to that fine, joyous and undaunted soul revealed so beautifully in the Life and Letters of Robert Louis Stevenson.

Alexander Davidson Bailey combines all these characteristics with an unsuspected fund of ripe scholarship that serves him well on occasions when he speaks in public. Forceful but witty, youthful but serious, learned but without ostentation, he is one of the best speakers in the electrical industry. Gaging him impartially, one can say that Bailey's outstanding characteristic is personality—something that men always strive for, but few ever attain.

New System for Burning Fuel Oil

AIR INTRODUCED ABOVE AND BELOW BURNING OIL PROVES AID TO COMBUSTION. BY CHARLES W. GEIGER

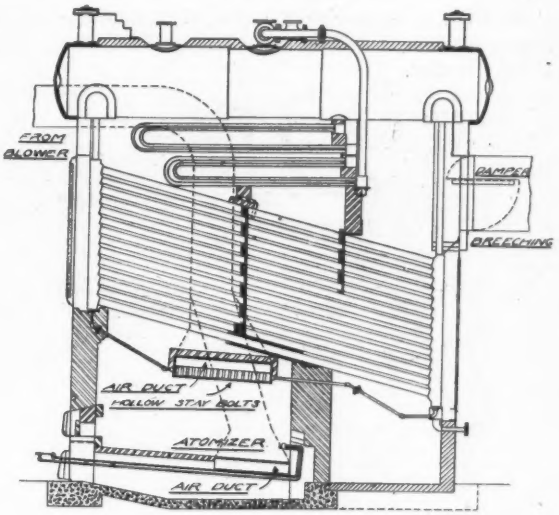
FACED by the shortage of hydroelectric power and fuel oil, many California inventors are devising ways to combat this menace. There is no fuel more abused than fuel oil. Many burners are extravagant and do not take into consideration that fuel oil must have the proper amount of air. The accompanying drawings show a new system recently perfected by John Price Hill, of San Francisco, which introduces the necessary fresh air supply both above and below the burning oil, rather than below it only, as is the present general method, thereby resulting in a saving of fuel oil.

Mr. Hill's invention makes it possible to utilize the hydrogen gases which exist in the oil by bringing the gases into direct contact with an accurate volume of fresh air.

This is done by means of two manifolds. One of the manifolds is hung between the flame and the water tubes of the boiler. This manifold is water cooled by being connected at both ends with the heads of the boilers. This manifold consists of tube sheets, through which tubes of the required size are inserted, permitting a water circulation around them. The top openings of the tubes connect with an air inlet duct by an air chamber immediately above the upper openings of the tubes, by means of which the required volume of air is forced downward into the rising flame and gases of combustion. These jets of air baffling the flame and gases of combustion form a thorough mixture for the lighter gases of combustion.

The lower manifold, with its perforations by means of which the required volume of air is forced upward, produces a still more perfect intermingling of the gases of combustion in the fire chamber.

The proper volume and pressure of air are provided by a blower system and damper regulation automatically controlled, which can be placed at any convenient point in the furnace room. Large air ducts lead from the blower to the upper and lower manifold. The lower manifold consists of only a single plate with the required number and size of perforations.



LONGITUDINAL SECTION OF BOILER EQUIPPED WITH NEW OIL BURNER

This invention can be installed in any boiler of any type or capacity without radical changes, and is applicable to marine boilers as well as stationary boilers. It can be operated in conjunction with either a back shot or a front shot burner.

With this system, there is no stack for the natural draft as the required air for combustion is delivered by the blower system.

U. S. CIVIL SERVICE COMMISSION announces an examination for aid, receipt of applications to close Dec. 21, 1920, to fill vacancies in the field service of the Lighthouse Service, at $1500 a year, and in positions requiring similar qualifications, at this or higher or lower salaries. It is the intention of the Bureau to make appointment to this position with a view to training appointees to fill the position of assistant superintendent by promotion, when vacancies in this position occur, at base salaries ranging from $1800 to $2500 a year, plus the bonus authorized by Congress. Apply for Form 1312, stating the exact title (Aid, Lighthouse Service).

Spillways for Reservoirs and Canals*

THEIR PURPOSE, METHODS OF CONTROL AND OPERATION BRIEFLY DISCUSSED. BY A. T. MITCHELSON

IN ITS ORDINARY use, the spillway is a device for removing surplus water from a reservoir or canal, in order that the water level within the reservoir or canal may not rise above the point considered safe or fixed upon as the maximum allowable height. It is distinguished from other types of wasteways by the fact that the surplus water passes over a crest, or "spills" instead of passing through openings in the dam or canal bank.

The conditions necessitating spillways are many and they vary as to the requirement for capacity, the degree of safety factor demanded, by the extent or importance of the structure they protect, the location of the spillway with relation to that of the dam and the functions they must perform in maintaining a more or less perfect control of the reservoir in times of maximum inflow when a predetermined flowage line or freeboard must not be exceeded.

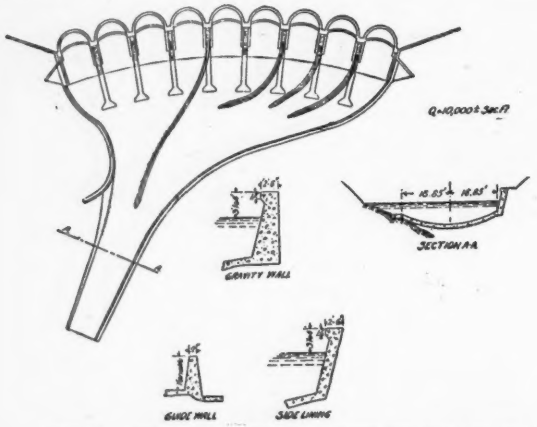


FIG. 1. FORM OF DENTATED TYPE OF SPILLWAY

If a reservoir is to be located in a stream channel where the extent of inflow is not under human control, the spillway must provide for the passage of both normal and flood flow when the reservoir is full and must protect the dam or embankment from being topped if it has not sufficient structural resistance to withstand the resultant shock, pressure and vibration imposed upon it by overflow of considerable depth. In the case of earth dams or embankments, it is necessary to provide a means for conveying the falling water away from the point where the embankment strikes the surface below it.

A spillway acts automatically and operates to prevent a rise in the canal level beyond a safe freeboard. The escape or spillway may include a checkgate as a part of the structure, in which case it must not only be capable of undertaking the duties of an overflow spillway, but those of an escape as well where the full capacity of the canal must be discharged. Ordinarily, however, the principal function of an overflow spillway is to discharge the surplus water above the desired normal canal capacity, whereas an escape is intended to spill the entire flow of the canal if necessary. An escape, on the other hand, embodies both types, but is intended for the protection of the system below it and to divert the entire flow of the canal to some natural drainage channel in case of a break or other emergency.

There are two general types of spillways, overflow spillways and siphon spillways. The distinguishing features of the two types are that the capacity of the overflow spillway depends upon the length of the crest and the height of the water above the crest, and is increased in no way by the distance through which the water falls below the crest; while the capacity of the siphon spillway depends upon the area of the cross-section at the smallest part of the siphon and the difference in the elevation of the water surface at the intake and outlet ends.

OVERFLOW SPILLWAYS

OVERFLOW SPILLWAYS are of three general types, the "ogee," the "steps," and the simple inclined type. Some dams combine the first two of these types by utilizing the top part as an ogee and having the lower portion stepped to break the velocity of the falling water.

Flow over a spillway is produced by the velocity resulting from the head measured from its crest to the surface of the water in the pond above. It depends entirely upon the stored head to increase volume per unit length, and, regardless of the height of the crest above the pool into which the water is spilled, no part of the fall below the crest level is effective either directly or indirectly. In other words, if a dam were 30 ft. higher than the surface of the tail water at its base, and there were 5 ft. of water pouring over its crest, of the 35 ft. available head only 5 ft., or about 14 per cent, would be utilized to produce velocity. Since the two principal factors determining capacity are length of crest and head and and the allowable increase in head is small, the only available means for increasing discharge is by increasing the length. One of these factors directly governs the other and only by knowing one of them definitely can the other be determined; or if the discharge of the stream is known and the head allowable as a depth of overflow is definitely fixed, the length of spillway to provide a specified discharge can be computed from the standard weir formulas. These formulas and their coefficients are very indefinite because of the fact that they have never been proven to be accurate for heads of more than 4 or 5 ft. over the crest of the weir.

Long crests discharging thin sheets of water will give greater factors of safety than short spillways with greater depths, will afford less liability to fracture or do other damage to the dam as a result of the impact of the heavier volume of water, and will insure closer regulation of the pond level.

Possibly the formula most used in the United States, in computing flow over spillways, is the Francis formula expressed in its simplest form as $Q = CLH^{3/2}$, and which is modified by the introduction of the elements referred to above wherever they apply. For instance, with velocity of approach this formula would be changed to read

$$Q = CL\,[(H + h)^{3/2} - h^{3/2}]$$

*Abstract from Bulletin issued by U. S. Dept. of Agriculture.

and if it considers velocity of approach and end contractions, it must still be modified to read

$$Q = C(L - 0.2H)\ [(H + h)^{3/2} - h^{3/2}]$$

In these formulas the symbols have the following significance

Q = Quantity of discharge, in cu. ft. per sec.
C = A coefficient, varying from 2.5 to 4.5, and determined from experiments on small models.
L = Length of weir crest, in feet.
H = Effective head, in ft.
h = Head, in ft. corresponding to velocity of approach.

So much depends upon the judgment of the person making the assumptions, which in turn become fixed factors in the computations, that there very often appears the greatest difference in the resulting dimensions. The uncertainty arising from the use of water to be discharged emphasizes the need of using a liberal factor of safety in the protection of that part of the structure to be guarded. At best the result is merely an approximation.

Spillway Control

It may be desirable normally to carry the water near the maximum allowable level rather than sufficiently below that to provide for emergency flow. This is provided for by placing the permanent crest of the spillway sufficiently low to pass the maximum flow, and placing on top of this temporary or movable parts which will go out automatically or can be removed or adjusted in case of flood so as not to interfere with floating debris. The immediate removal of these barriers is of particular importance, because having provided an ample spillway it should be kept free of any obstruction and at all times ready for any sudden demands made upon it, regardless of other agencies which may be provided as additional facilities in effecting discharge. Inadequate satisfaction of these conditions has led to a great number of wrecked structures resulting in the loss of life and property. Long crests to keep the rise of the pond level within a minimum limit have been built and where the site did not permit of a straight-line crest, modification of the form has been made as in the case of the East Park reservoir of the Orland project, where crest length was gained by forming it in a series of nine semicircular arches resting against piers 8 ft. wide. The arches have a radius of 13.5 ft. and the whole structure is curved to a radius of 474 ft., the total length of spillway crest being 460 ft. It was designed to care for a discharge of 10,000 second-feet with a depth of 3.7 ft. of water flowing over the crest. The spillway is located in a saddle about one mile from the dam and its outline is shown in Fig. 1.

When acceleration is due to a shorter crest length and a resulting increase in the head to effect discharge, the devices serving to produce a regulated pond level must be under direct control. The addition of such devices invariably serves the primary purpose of the spillway in facilitating the escape of the increased inflow, but lacks the automatic character which must be the distinctive feature of the true spillway. These agencies may be (1) flashboards in their various forms; (2) sliding gates or sluiceways; (3) Taintor or radial gates; (4) tilting or counterweighted gates; and (5) rolling dams or barriers.

Flashboards

Flashboards are the simplest but most unsatisfactory devices. They permit of fairly close regulation of head due to the possibility of setting them to any desired width. The boards may be placed between stationary piers or may be held in place by tilting arms or braces set in line on the crest of the spillway so that they may not retard flow during flood, but will afford a certain pondage to provide surplus water from the time of minimum to that of maximum demand.

Another method is to have holes in the crest of the dam or spillway into which iron pins are set and the boards fastened to these pins by staples. The pins are calculated to resist pressure of the flashboards set against them up to a certain point and when they bend the boards are released and go down the stream.

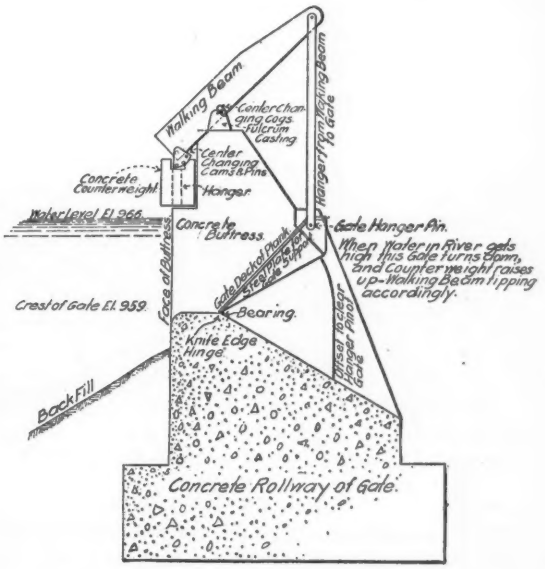

Walking Beam
Center changing Cogs. Fulcrum Casting
Center Changing Cams & Pins
Concrete Counterweight
Hanger
Water Level El. 968
Concrete Buttress
Gate Hanger Pin.
When Water in River gets high this Gate turns Down, and Counterweight raises up-Walking Beam Tipping accordingly.
Face of Buttress
Gate Deck of Pedestal
Crest of Gate El. 959
Bearing.
Knife Edge Hinge
Back Fill
Concrete Roll way of Gate.

FIG. 2. CONCRETE DAM 17 FT. HIGH FITTED WITH AUTOMATIC FLOOD GATES

Such practice is not economical and is uncertain, due to the great variation in the strength of the iron pins. Where the storage of flood water is essential or desirable and the stored water is very valuable, this use of flashboards is not recommended, because they are generally leaky, and when they have gone out they cannot be replaced until the freshet or flood has passed, making it impossible to store any of the flood water.

Sliding Gates

Sliding gates are not adapted to use as emergency escapes for flood water, since they are not automatic in action, although ordinarily they are provided with mechanical means for quick operation. The cost of installation and operation is a large factor in discouraging their use. They are useful as a means of entirely emptying a reservoir in case of accident or to scour out silt when they are placed low for these purposes, and they should be provided only as an additional safeguard and not when the passage of flood water in excess of the safe flow is required.

Taintor or Radial Gates

Taintor or radial gates are usually set between piers as buttresses and on the crest of a spillway to provide additional storage. They can be operated with the expenditure of less power and time than the other types of gates. They have cylindrical surfaces and are so connected as to revolve on an axle usually connected to the curved face by means of arms or braces, the axle being set parallel to the center line of the crest on which the gate is mounted.

The main objection to the use of the radial gate is that it lacks automatic control, unless its specifications of installation more properly conform to the class following, and the fact that it is seldom watertight where

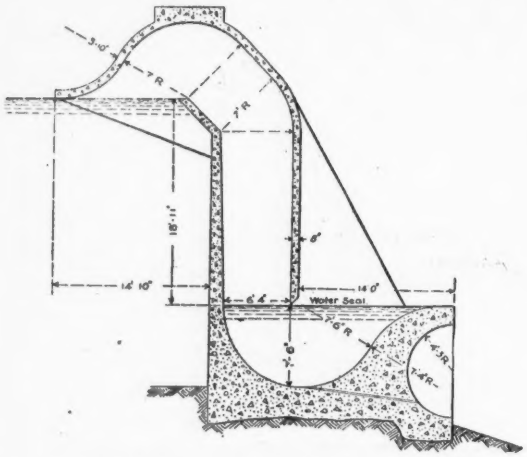


FIG. 3. EXAMPLE OF SIPHON SPILLWAY FOR USE WHERE NO TRASH OR FLOATING ICE IS PRESENT TO CLOG THROAT

it comes in contact with the crest of the spillway or the sides of the opening.

Tilting or Counterweighted Gates

Tilting or counterweighted gates are among the number of ingenious types of automatic gates which have been designed and installed on spillway structures in this country and in Europe where it is necessary or desirable to maintain a relatively constant head under fluctuations, floods, or changeable use of water.

An automatic form of spillway or floodgate has been installed on the Cedar River, near Nashua, Iowa. The design is one of the many patented types, but seems to be of simple operation. Figure 2 shows an outline of the structure, which is mounted on the top of a masonry dam 17 ft. high and used for the generation of electric power. Each panel of the gate is 46 ft. long and is so set that it will store 7 ft. of water above the crest of the dam. To one end of a walking beam there is attached a reinforced concrete counterweight and a bar connects the other end with the floodgates. The gate is hinged at the bottom so that when the water rises above a predetermined elevation the gate is forced down and the counterweight is raised. As the height of water increases, the pressure still further lowers the gate. When the gate opens, the leverage between the counterweight and fulcrum increases, while it decreases between the fulcrum and gate hinges, and in this way overcomes the increased weight of water at every stage of gate opening.

Rolling Dams or Barriers

The rolling dam is a patented type and consists of a large hollow cylinder, the diameter of which is usually made to correspond to the height to which it is desired to raise the pond level above the crest upon which the cylinder rests. Its length is made equal to the width of the opening into which it is fitted. As a general thing, the material of which it is made is boiler plate riveted together and braced to withstand the strain to which the dam is to be subjected. The mechanical operation is provided for by having a gear engage a rack on an inclined abutment and by means of a sprocket chain wrapped around one end of the cylinder and connecting with the operating mechanism, the dam is rolled up or down the abutment as desired.

All these devices, as stated, are for spillway control and add nothing to its capacity or its value as an automatic structure other than to lower the crest in times of flood and permit of raising the water level in normal times.

Siphon Spillways

As long ago as 1870, siphon spillways were used in Europe, but their operation required an ejector to cause them to function properly. Later designs, making them

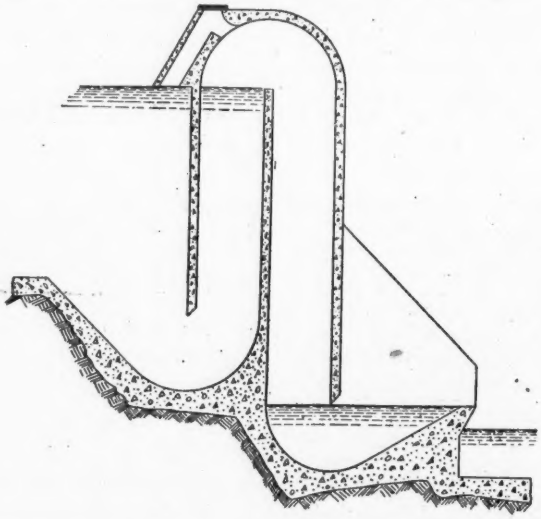


FIG. 4. EXAMPLE OF SIPHON SPILLWAY WITH SUBMERGED INTAKE LIP AND SURFACE AIR CONTROL

as nearly automatic as construction conditions permitted, were perfected and installed at about the same time by Heyn in Prussia, and Gregotti in Italy.

There should be little argument against the use of the siphon spillway on canals or in connection with reservoirs where absolutely automatic control without the maintenance of mechanically operated devices is desired, and where there must be close regulation of the rise and fall of the water surface. Economy of cost, space, and rapidity of control greatly argue in favor of such structures, especially where laws require close regulation of the pond level, as in Italy, where 8 in. is the limiting range. It is also most efficient where imme-

diate response to sudden rises in water level is essential, because of the fact that it is brought into action to its full capacity with the rise of only a few inches, whereas the overfall spillway is not fully effective until the danger point is reached and then is dependent upon the stored head for acceleration of velocity.

Flow through a siphon is produced by the difference in the elevation of the water surface at the inlet of the siphon and the elevation of the water surface at the outlet end; or in case the latter is not submerged to seal the siphon, and the water has a free discharge, it is measured to the center of the outlet opening. The tendency of design has been in most cases to assume that heads in excess of 34 ft. were not adaptable to siphon installations, because it was accepted that the limit of vacuum draft had been reached at that point. As a matter of fact, siphons have been built with heads beyond 34 ft. and in specific cases from 35 to 52 ft., but always, of course, with a resulting decrease in the co-efficient of discharge due to added frictional resistance. It is generally accepted from a study of numerous designs that two forms of siphon tubes may be considered. The first of these has the throat and outlet of equal cross section, but not necessarily of uniform shape.

The second type has a contracted throat section, expanding with a divergent tube as the outlet and further modified to overcome local losses of head, or contributing defects. There are numerous examples of the latter type, and their installation has been generally adopted in the United States and in Europe, so that most of the experiments conducted to determine efficiency, or the lack of it, have been on this type.

The formula $Q = kA\sqrt{2gH}$, in which k is a coefficient ranging from 0.50 to 0.80 and g is the acceleration of velocity due to gravity, is used as the basis for figuring discharge. While this expresses the quantity discharged, the accurate design of one of these structures will necessarily require more thorough search into the theory of the hydraulic features such as would enter into any tendency to retard flow and thereby reduce the efficiency of the whole structure.

Theoretically, fixed rules have been adopted and practice has shown the advisability of having the overpour crest of the throat at the same elevation as the normal water level in the reservoir. For starting siphonic action, the inlet must be sealed by the water as soon as the water in the reservoir rises above this normal height and climatic or other conditions may make this a matter of choice as to which of two methods will be used. The inlet lip can be made to extend down to the normal water surface or a very slight distance below it, so that action ceases; or the inlet lip is extended to a considerable depth below the water surface, and the highest point in the crown of the siphon is connected with air inlets either fixed or regulated to admit air to the crown at the desired stage of water surface and break siphonic action. This latter case is used and is desirable when floating material may interfere with the proper action of the siphon. The contrast in the two designs is shown by Figs. 3 and 4 as installed in Europe.

Survey of Power Plant Projects in South America

PREPARED BY THE GUARANTY TRUST CO. OF NEW YORK

THE COUNTRIES of South America possess vast resources for the development of hydroelectric power. In support of such a development, efforts are being made to cheapen the cost of fuel for transportation and other purposes, coal being not only very high priced but also difficult to obtain, and to extend railways so that interior sections may be made accessible.

In Argentina, the Iguazu of the northeastern corner of the country, and the great group of water power resources in northwestern Patagonia, Neuquen, Rio Negro and Chubut are capable of producing enormous quantities of hydroelectric power. Due to their remote locations, they have attracted less attention than the limited resources of Cordoba, Tucuman, and Mendoza.

The falls of the Iguazu afford the best single resource in Argentina and one of the best in the world. Accordingly, the Argentine Government, under the Direccion General de Navegacion y Puertos, has inaugurated a survey preliminary to the construction of a power plant there. It is reported that an international power plant, with a capacity of 150,000 hp., will be erected jointly by the Governments of Argentina, Uruguay, and Brazil. At present, La Compania Hidroelectrica de Tucuman (English) is the only power plant established in Argentina. La Emphesa de Luz y Fuerza (German) has a concession for the construction of a power plant at Mendoza. Work on this plant was begun several years ago, but was indefinitely suspended because of a dispute over the concession. The Municipality of Mendoza is to construct a power station at the falls of the Rio Blanco and to build an extension tunnel and aqueduct system costing $5,600,000.

Dr. Julius Klein, the United States Commercial Attache to the Argentine Republic, says that power plants could well be established near Salta in the northwest, near Iguazu, and in the Rio Negro district, to serve Bahia Blanca of the southeast, and that there will be a great demand for electric power for supplying the various railroads which contemplate the electrification of their lines. At the present time, the Argentine railways use three-fourths of the coal consumed in Argentina.

BRAZIL

BRAZIL has extensive plans for the development of interior transportation, including the construction of power plants for industries and the electrification of railways. The Director of Public Lands and Colonization, Department of Public Works, Porto Alegre, Rio Grande do Sul, called last August for bids for the erection of a power plant of 30,000 hp. on the river Jacuhy. The concession is for 30 yr. at the expiration of which time the State will take over the installations. La Empresa Electrica de Jundiahy and the Sao Paulo Electric Co. have 10-yr. contracts for furnishing 8,400,000 kw.-hr. of power for the Paulista railway, which is now being electrified. The Government owned line from

Barra to Pirahy of the Central Railway of Brazil is also to be electrified. Rio de Janeiro is to have a 270,000 hp. plant erected in the near future by an internationally organized company having American interests, according to Dr. Julius Klein, United States Commercial Attache to Buenos Aires. Two hydroelectric stations are to be built and an electric street car service inaugurated in the vicinity of Rio de Janeiro.

The Itabira Iron Ore Co., Limited, recently secured a concession from the Brazilian Government to construct and exploit high temperature furnaces, a steel factory, and reducing apparatus, etc., and plans to electrify the Victoria-Minas railway, for which an electric power plant will doubtless be constructed. An electric smelting plant, the first of its kind in South America, will be built in Ribeiro Preto, Province of Sao Paulo, by the Companhia Electrica Metallurgica Brazileira. The construction of the mill will be started as soon as the American contractors can get their engineers on the ground. The mill will be 75 mi. from the mines of iron ore in the Province of Minas Geraes.

Bolivia

Bolivia in its present stage of development is a country of mines, though other resources exist. There are only three or four towns of any importance and population, and the present field for street railroad and power transmission material is restricted. The greatest hydroelectric resources are those in the vicinity of La Paz, Tres Cruces, and Colquechaca and plans for their exploitation have been made. The three initial power plants will entail an expenditure of $10,000,000 and will require large quantities of other machinery and electrical accessories in addition.

The La Paz-Yungas electric railroad is now being constructed by the Bolivian Government with funds largely raised through a $2,400,000 loan made in the United States a few years ago. This line and the Corocoro copper mines, whose directors are considering the electrification of their plant and the City of La Paz itself, for lighting, heating, cooking and industrial purposes, will utilize power supplied from the Yungas River near La Paz.

The progressive mining section of Tres Cruces requires power and heat and needs two tramways operated by electricity to connect Oruro and Cochabamba. The Cochabamba-Valparaiso Railroad needs capital to complete the electrification of its system and to reconstruct its lines to meter width.

The wealthy mining district of Colquochaca lacks electric power and heat, and an extension of the railway to Uncia, another mining center, is urgently needed.

Electric lighting plants exist in about a dozen towns and tramways in three or four.

The Bolivian and General Enterprise Co. operates the tramways, electric lighting and telephone systems of La Paz, a city of 100,000 population, the capital of Bolivia. This company is owned almost entirely by the French munitions firm of Creusot and Schneider. The power is hydroelectric and the tramway line is approximately 3 mi. in length, operated with eight cars of American make.

La Sociedad de Luz y Fuerza Electrica de Cochabamba, a local firm capitalized at $2,000,000, operates the previously mentioned interurban line terminating in Cochabamba and also furnishes light and power to the towns along the line, Arami, Vinto, Puncta, Tarata, and Cliza. The hydroelectric station on the Chocaya River supplies the power.

Sucre, the capital city, sadly lacks modern transportation facilities. La Empresa de Luz y Fuerza Electrica de Sucre has a monopoly of the light and power supply of the city. La Empresa de Luz y Fuerza de Oruro, a hydroelectric development, has lighting and power privileges. It is a local concern. A mule tramway still exists in this town of 23,000 persons.

Tarija and Potosi have hydroelectric light and power, the former from Erquis, 6 mi. distant, and the latter from 32 servoirs built by the Spaniards in the sixteenth century on the hills above the city.

Hydroelectric power is beginning to be utilized by the tin and copper mines of Bolivia. The Guggenheims of New York have acquired rights to three tin mines in the Department of La Paz, consisting of more than 4000 hectares. Water and power rights to some six streams in the vicinity of the mines have been secured and a hydroelectric power plant is to be built, but the site has not been decided on. The installation of a smelting plant run by electricity is under consideration. The company plans to found a town below the mines and construct an electric railway to it.

The Bolivian Government has been for some time contemplating the electrification of all railways and has declared as public domain the waters of such rivers as are capable of being used for the development of power. The Jafe de la Seccion de Ferrocarriles del Ministerio de Fomento has charge of these projects.

Peru

In Peru, most of the important cities and towns have electric light and power systems. Tramway systems traverse the streets of Lima, Callao, and towns adjacent thereto, and are also established at Arequipa. La Empresa de Telefonos Arequipa y Mollendo operate the local and long distance telephone system of Arequipa and surrounding district.

Las Empresas Electricas Asociadas de Lima (Lima Light, Power and Tramways Co.) controlling electricity and gas franchises in and adjacent to Lima, as well as more than 86 mi. of tramway, is the most important public-utility company in Peru.

La Sociedad Electrica de Arequipa, Ltd., a local company, furnishes electricity for light and power to Arequipa, the metropolis of Southern Peru and its environs. El Tranvia Electrica de Arequipa, Ltd., controls the traction service of that city; W. R. Grace and Co., as agents for the Bond-holders' Syndicate, operate the line.

Various sections of the Peruvian railways are being electrified as power for that purpose is provided, especially the interurban lines near Lima. The last division of the Southern Railway of Peru (from Mollendo to Arequipa, Puno, Cuzco and from Gaqui, beyond Lake Titicaca, to La Paz, Bolivia) is an electric 6-mi. line.

The mines of Peru are beginning to appropriate the hydroelectric resources of the Peruvian Andes. The Cerro de Pasco Copper Corporation of Cerro de Pasco, Province of Junin, Peru, is now installing a large

up-to-date smelter at Oroya and providing modern housing and other facilities for its workingmen, all of which will consume considerable electric power, which is likewise being provided.

A vanadium ore-reducing plant for the mines of Minasgra, Peru, is to be built at Jumasha, Peru, by the Vanadium Corporation of America, of Pittsburgh, Pa. A hydroelectric plant capable of furnishing 20,000 kw. for treating the ore is to be constructed about 25 mi. from Jumasha.

Ecuador and Chile

In Ecuador, public utility development has been very slow. In Quito, the capital, there is an electric tramway line installed by J. G. White & Co. This, together with the Quito Electric Lighting & Power Co., which furnishes light and power, is owned by the Ecuadorian Corporation, a British company. Guayaquil, the largest city and chief port, has two street car lines and electric lighting. The municipality of Portoviejo is to erect an electric light plant.

Chile has vast hydroelectric resources, which have been but slightly developed. German and British capital, chiefly, has been invested to provide public utilities in Chile.

The most definite development project in Chile at the present time is that provided by a $35,000,000 loan by the Chilean Government, $10,000,000 of which has been appropriated for the electrification of the railway from Santiago to Valparaiso, via Casablanca. The electric generating station is to be located on the Aconcagua River about 30 mi. from Llai-Llai. In fact the Chilean Government will electrify all the State railways, and plans are in charge of Sonores Rafael Edwards, the electrical consulting engineer for the State railways, and Ricardo Solar, a civil and electrical engineer of prominence.

Moreover, an internationally organized company (Anglo-Chileno-Americano) in Valparaiso plans to construct a 100,000-hp. plant for supplying electric lighting and power to that region.

The Antofogasta-La Paz Railway, a British-owned line and one of the largest in the nitrate region of northern Chile, is to electrify its lines at a cost of $7,500,000, which project will entail the erection of a power plant.

Colombia and Venezuela

Colombia with her abundant hydroelectric resources, about five electric light and power plants representing about one million dollars, and various electric and steam tramways, operated in the five chief cities, exhibits an attractive field for electric installations. Her cities are becoming modernized with the development of her industries and her mineral resources are being exploited as never before. A power company in Zipaquira is to construct a new plant near the Neusa River. Irrigation interests in Tolima will construct several large locks at La Bolsa near Espinal to facilitate the installation of an electric plant to provide lighting for El Espinal, Guamo, and El Chicoral.

A number of the larger Venezuelan cities and towns have electric lighting and tram service. The Caracas Electric Co. utilizes the 111-ft. rapids in the Guare River for the generation of power. The torrential Chama River near Merida is likewise useful. The Caroni Falls will be harnessed to provide the necessary hydroelectric power for the newly planned electric railway from San Felix on the Orinoco River to the Guasipati gold fields.

The New Era

By Chas. R. Tighe

LITTLE thought is given to the rapid strides in the last three centuries of power development. Yet in that comparatively short time, two great and distinct advances have been made in the utilization of power.

The tedious methods of several hundred years ago when distance on land was covered by horse or on foot and travel on water depended entirely upon the wind and muscular power, were superseded by steam.

Development of steam power had the immediate effect of speeding up the world which was further augmented in recent years by electric power. Industries now produce many times more than formerly; travel by land and sea, over great distances has become a matter of days instead of weeks and months; men travel under water as well as in the air.

Coal and oil are two of nature's blessings which are contributing to the development of power, but the world is now faced with the grave fact that some day these resources will give out. Even at the present time, there is an insufficient quantity of this fuel to satisfy rapidly increasing demands. Coal shortages have already been experienced with a consequent slowing down of industries, shortages of commodities and increase in prices.

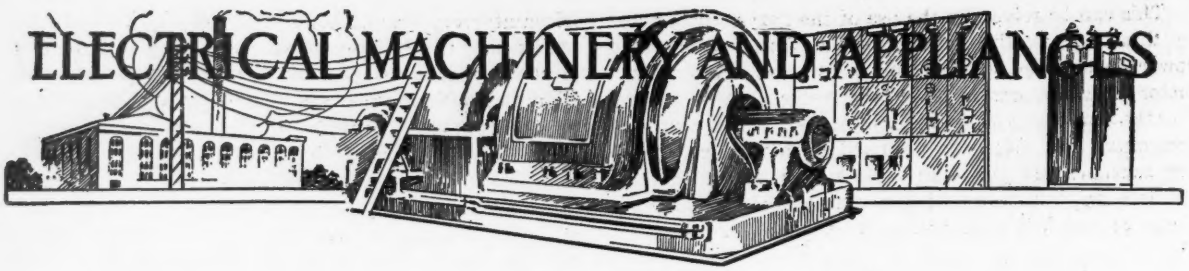
There is, however, another great inexhaustible, practically untapped supply of power-producing material. The swiftly flowing streams, turbulent rapids and water falls will furnish much of the power of tomorrow. Man is realizing more every day the great need for development in this direction and a few scattered projects have been built or are in course of construction.

Millions of horsepower every day are going to waste. The supply is constant and inexhaustible. It is cheap. Harnessing of the "white coal" possesses no great engineering difficulties. Benefits derived from its development will be of enormous economic worth. The menace of coal shortage will be in great measure a thing of the past.

In those districts where a bountiful supply of water-power can be obtained, industries will locate and vastly increased prosperity will take place. The power thus produced can be used to keep the industrial machinery running smoothly with a maximum amount of efficiency as well as for lighting purposes in factory, home and city.

The present-day freight congestion will be practically a thing of the past. The necessity of transporting great quantities of coal will cease to exist. Thousands of freight cars used for this purpose will be diverted to use for transportation of other commodities.

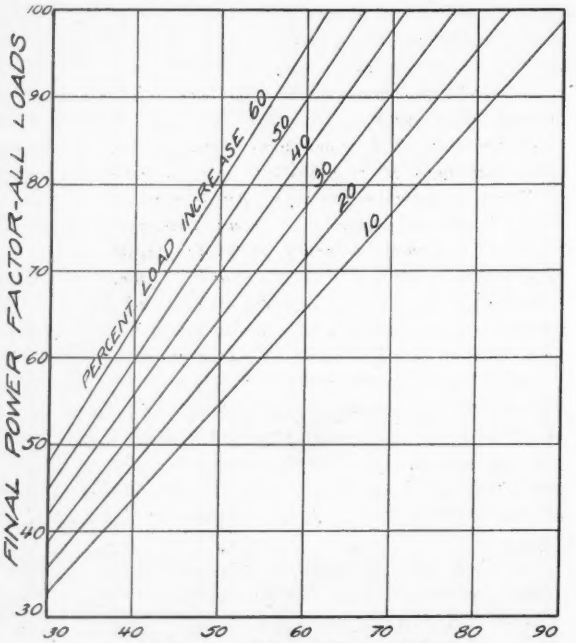
Eighty applications have been received by the Federal Power Commission for preliminary permits and licenses to develop water power sites. Revision of these applications to conform to regulations is going forward rapidly and many corrected applications are now ready for consideration.



Power Factor Correction by Synchronous Motors

DISCUSSION OF GRAPHICAL METHODS APPLICABLE TO THE USE OF THE OPERATING ENGINEER. BY VICTOR H. TODD

WHEN an industrial plant is first laid out, the designer usually tries to make provision to take care of the increase in power demands for a number of years in the future. Yet in spite of the most optimistic designing and planning, there often comes a time when the engineer in charge of the power plant is confronted with the problem of supplying the ever increasing demand for more power. If the plant be direct current, and the full capacity is reached, there is usually only one thing to do, and that is install new generating equipment; but with alternating current, a large demand can usually be satisfied without additional equipment simply by raising the power factor.



1ST. DETERMINE THE INCREASE IN LOAD IN PER CENT OF INITIAL KW. CAPACITY.

2ND. LOCATE THE INITIAL POWER FACTOR.

3RD. FOLLOW THIS LINE VERTICALLY TO INTERSECT THE INCREASE IN LOAD.

4TH. FOLLOW THIS INTERSECTION TO THE LEFT AND LOCATE THE FINAL FACTOR.

FIG. 1. GRAPH SHOWING RELATION BETWEEN INCREASED CAPACITY AND RAISING OF POWER FACTOR

In most plants, it will be found that the power factor is quite low due to the fact that the growth of the load has been induction motors added as required without much thought of low power factor, as there was plenty of excess capacity in the generators. But when the kilovolt-ampere capacity of the machines is reached, and more load must be added, then the power factor must be raised and raising the power factor is not only as good as installing larger apparatus, but the efficiency of the existing equipment is increased and its regulation improved.

The problem of increasing the power factor may be solved in a number of different ways, depending on the existing conditions and whether corrective apparatus is on hand, must be purchased second-hand, or must be purchased new.

ADDITIONAL CAPACITY RENDERED AVAILABLE

IN THE majority of cases, the great question is: How much must the power factor be increased to give a certain per cent increase in capacity? For instance, on a 750-kv.a. system carrying a load of 450 kw. at 60 per cent power factor, it is decided that the load must be increased 40 per cent or in other words increased from 450 to 630 kw. Since the kv.a. of the system is the same (750 kv.a.) and the power factor is the ratio of the kw. to the kv.a., it follows that the power factor must be increased to $630 \div 750 = 84$ per cent to handle the increased load without exceeding the kv.a. of the system.

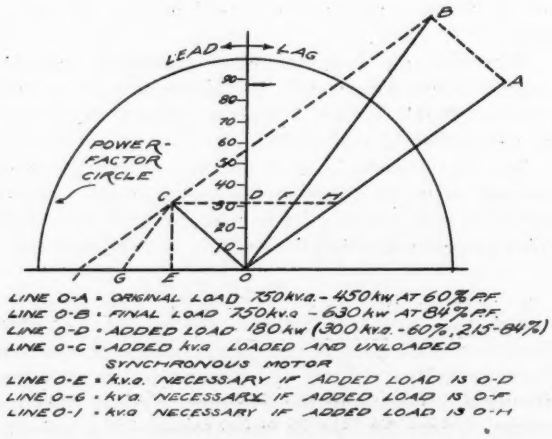


FIG. 2. VECTOR DIAGRAM FOR DETERMINATION OF SYNCHRONOUS CONDENSER CAPACITY

This can be solved by the use of the curves in Fig. 1. In these curves, the horizontal line shows the initial power factor, the vertical line shows the final power factor and the curves show the percentage increase. To take our previous example, locate 60 per cent on the horizontal line, follow it up until it intercepts the 40 per cent increase curve and follow this intersection to the left until it shows 84 per cent as the final power factor on the left hand vertical.

Raising the Power Factor

Now that it has been decided how much the power factor must be raised, the question is how to raise it. There are four ways of doing this with corrective devices: (1) by the static condenser; (2) by the unloaded synchronous motor; (3) by the partially loaded synchronous motor; (4) by the fully loaded synchronous motor.

Where to Use Static Condensers

If the only object in view is to raise the power factor to render additional capacity available and additional motors are already on hand to supply the additional load, or if it is simply to secure higher efficiency and better voltage regulation, then it would be well to investigate the use of a static condenser. In the smaller size, the price of a static condenser is less per kv.a. than a synchronous motor. The curve between the kv.a. capacity of a static condenser and its initial cost is almost a straight line, while the curve of the kv.a. and cost of a synchronous motor is a curved line. Therefore, there is a point where the cost of a static condenser and a synchronous motor are approximately equal. This is in the neighborhood of 400 to 500 kv.a. This means that, neglecting maintenance costs and considering only initial costs, below 500 kv.a. the static condenser is the cheaper,

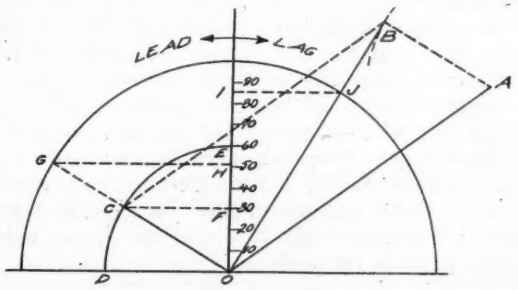


FIG. 3. VECTORS INDICATING LOAD TO BE CARRIED BY A SYNCHRONOUS MOTOR TO GIVE A MAXIMUM POWER FACTOR CORRECTION

while above 500 kv.a. the synchronous motor is cheaper. Of course conditions vary as to the attendance required, but if an attendant will be required merely for the synchronous motor then one is warranted in spending more money to obtain more capacity in a static condenser than the initial cost would indicate.

The Synchronous Condenser

The corrective effect of an unloaded synchronous motor is exactly the same as the static condenser as the slight runing losses may be disregarded. The question now is: What capacity synchronous motor or static condenser must be used to increase the power factor a certain percentage? This can best be solved by vector diagrams as shown in Fig. 2. The vertical line represents the power factor of any radial line by drawing a horizontal from the intersection of the line and the power factor circle. Draw line OA so that it intersects the power factor circle at 60 per cent, and such that its length represents the kv.a. of the system. (750 kv.a. in this example.) Now suppose an additional load of 180 kw. is to be added bringing the total load up to 630 kw. and the kv.a. remaining the same. Therefore lines OA and OB must be equal in length. It will be noted that in order to obtain this result, the total added load plus the correction must be 260 kv.a. at 36 per cent leading power factor (line OC or AB). But the capacity of the synchronous motor depends on the power factor of the added load of 180 kw. If this is at 100 per cent (line OD) then the capacity of the motor or condenser must be at 180 kv.a. at 0 per cent lead (line OE). If the 180 kw. is at 84 per cent (line OF) then the capacity must be 300 kv.a. (line OG). If the 180 kw. is at 60 per cent (line OH) then the corrective capacity needed is 425 kv.a. (line OI), and so on.

The Partially Loaded Synchronous Motor

By carefully examining the vectors in Fig. 2, the very surprising condition will be noticed that a given

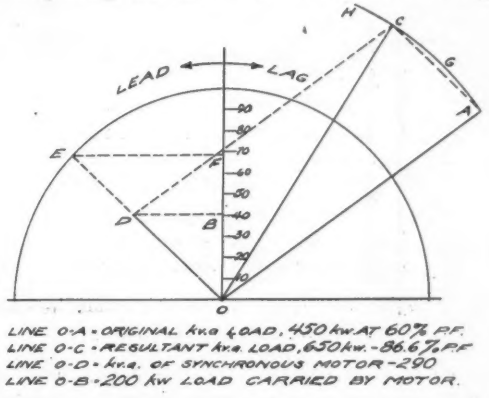


FIG. 4. VECTOR FOR SOLUTION OF PROBLEM WHEN LOAD IS GIVEN

capacity motor may have a greater corrective effect while delivering a mechanical load in addition to performing its corrective duties. For instance, in the diagram assume that we have a load of induction motors taking 180 kw. at 60 per cent power factor. It has already been shown that it takes a 425 kv.a. synchronous motor running at 0 per cent power factor leading, to give the desired correction. But suppose we discard the induction motors entirely and throw the mechanical load of 180 kw. directly on the synchronous motor running it at 70 per cent leading power factor. The vectors show that not only does the motor carry the load and give the desired correction, but in addition the capacity of the motor need be only 260 kv.a.

This leads to the important rule that *adding mechanical load to a synchronous motor will enable it to give more correction than if it is run merely as a condenser.*

The problem may now resolve itself into the following form: With a given kv.a. and kw. of a system and a given kv.a. of synchronous motor, what is the maximum correction it will give and what is the mechanical load it must carry to give this correction? Let us assume as before that we have a 750-kv.a. system loaded with 450 kw. at 60 per cent. A 300-kv.a. synchronous motor is available for correction purposes and may also carry

load. Line OA in Fig. 3 represents the kv.a. of the system; the kv.a. of the synchronous motor may be represented by any radial line terminating at the circle DCE, from line OE where the motor is unloaded at its full kv.a. through OC where it is partially loaded to OE where it is fully loaded at 100 per cent power factor. Duplicating this circle with a radius at A shows that the maximum power factor correction will attain when the resultant kv.a. after correction (line OB) is tangent to the kv.a. circle of the synchronous motor. Drawing resultant OB and completing the parallelogram by line AB will give line OC as the position of the kv.a. of the synchronous motor. Projecting point C to the vertical gives OF or 150 kw. as the mechanical load. Continuing OC to the power factor circle and projecting G to H shows that the power factor is just 50 per cent.

Projecting point J where the resultant crosses the power factor circle to I, shows that the power factor of the total system is now 86 per cent. It is also readily apparent that if the motor carries more or less mechanical load, the resultant OB will intersect the synchronous

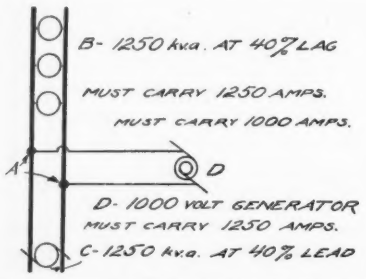


FIG. 5. ILLUSTRATING NEED OF PLACING CORRECTIVE DEVICE AS NEAR LOAD AS POSSIBLE

motor circle at a different point and any other point except B will give a lower power factor to the resultant.

Problem When Load Is Given

There is still another case which may confront the engineer in which a definite mechanical load must be carried and the synchronous motor must not only carry the load, but must increase the power factor of the system sufficiently to carry the increased load without exceeding the maximum kv.a. of the system.

Let us assume as before that the original kv.a. of the system is 750 with a load of 450 kw. at 60 per cent. This is shown by line OA in Fig. 4. To this must be added a mechanical load of 200 kw. This is shown by line OB. Now it is evident that the resultant kv.a. must fall on the circle HCAG and also that point C must be 200 kw. higher than point A. Or it may be figured before that if 200 kw. is added to 450 kw., the result must be 650 kw. at 86.6 per cent power factor to still give 750 kv.a., and the line OC drawn through the 86.6 per cent power factor intersection of the power factor circle. Line AC now shows the kv.a. necessary for correction which, drawn in its proper position, becomes line OD, which shows that the motor must be of about 290 kv.a. capacity, carrying a mechanical load of about 200 kw. at 70 per cent power factor leading to give the resultant OC. This power factor of 70 per cent leading is obtained by prolonging OD until it intercepts the power factor circle and then projecting it to F, where line OF shows 70 per cent power factor.

Other presentations of the problem such as finding the resultant kv.a. load on the system or the resultant power factor of the system after the addition of a specified size and load of a synchronous motor, should be readily solved by simple vector diagrams from a careful consideration of the foregoing. This applies also to the fully loaded synchronous motor, it being a simple problem of laying off the kv.a. of the system, the load on the motor, and finding the resultant kv.a. from the length of the resultant on to the vertical and scaling the length of this projection; and the resultant power factor by projecting the intersection of the resultant and the power factor circle on to the vertical and scaling this vertical for the power factor.

Location of Corrective Apparatus

This subject cannot be treated at length in the present discussion, but should be made the subject of careful consideration before the actual location is determined. It must be borne in mind that there is always a wattless current flowing between the load and the corrective apparatus. Consequently, up to the point where the two combine, the cables must be sufficiently large enough to carry the actual current as called for by the kv.a. of the load and the kv.a. of the corrective devices. For instance in Fig. 5 if the load is 500 kw. at 40 per cent lag and the corrective device is 500 kw. at 40 per cent lead, then the kv.a. load on each is 1250 kv.a. and assuming single phase at 1000 v. the cables from point A to B and from A to C must be large enough to carry 1240 amp. But the total kv.a. is only 1000, so at 1000 v. the cables from A to D need be only large enough to carry 1000 amp.

This plainly shows why the corrective devices must be placed as near the load as possible. If placed near the generator, they may relieve the generator from excessive field heating and improve regulation, but in this location they will not relieve the transmission lines or the transformers. From this it will be seen that a great many factors enter into the consideration of increasing the power factor and the greatest success and highest efficiency is obtained only by giving the correct weight to every point in the problem.

The degree to which expenses of power plants have increased is well shown in the report of the Wallingford, Conn., municipal plant recently made by the Board of Electrical Commissioners. Receipts and expenditures rose as follows:

	1918 per cent	1919 per cent	1920 per cent
Operating income	11.4	16.6	23.
Power load income	76.8	24.6	43.
Fuel cost	143.8	5.8	20.7
Labor cost	33.4	26.3	29.3
Total operating cost	62.5	7.6	28.

Teacher: "Give me a definition of the word volt."
Student: "A volt is a mule's half brother."
Teacher: "Absurd. Explain yourself."
Student: "It always kicks you when you least expect it."

Underground Electric Distribution Systems*

FORMS OF CONSTRUCTION, INSTALLATION OF CABLES AND ARRANGEMENTS OF SYSTEMS EMPLOYED. BY A. L. FRERET

IN DESIGNING a distribution system, the first things to be considered are the type of installation and the kind of conductors. There are three methods for installing underground conductors: (a) in a tunnel; (b) in ducts; (c) or by burying directly in the earth.

The tunnel has many advantages over any other underground system. Some of these advantages are: better ventilation; accessibility of conductors, allowing frequent inspection; and ample space for the installation of many cables. But its great initial cost makes it prohibitive.

Figure 1 is a cross-section showing view of an underground system of the tunnel type. This tunnel is about 1300 ft. long and connects the main transformer station with two mill substations. The three conductor cables shown are varnished cambric insulated, lead covered, 600,000 c.m. and 300,000 c.m. respectively. They have a rated voltage of 11,500—the working voltage is 6600.

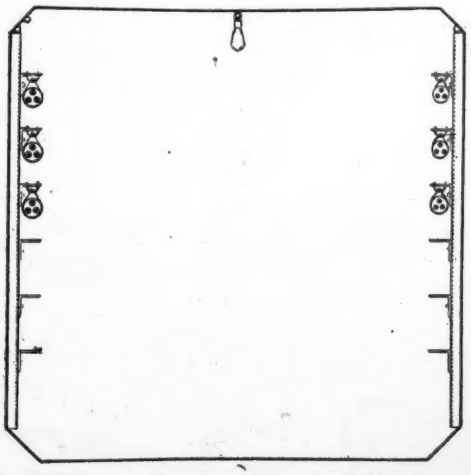


FIG. 1. SECTION THROUGH TYPICAL UNDERGROUND CABLE TUNNEL

Figure 2 shows high and low tension cables as well as direct current conductors from substation to mills. The 6600-v. main motor cables are three-conductor varnished cambric insulated lead covered. The 240-v. alternating-current feeders are composed of three single conductors, varnished cambric insulated for 600, and each cable is covered with three flame-proof braids. These cables are supported on three-conductor clamps.

Figure 3 shows arrangement of cables and method of support. Attention is called to the method used in supporting the lead covered cable, this being accomplished by means of steel messenger and rings similar to that used in telephone work, thus distributing the weight evenly upon the lead sheath and allowing greater distance between main supports. In the case of alternating-current single conductor cables, the three-way clamp shown reduces inductance to a minimum.

*From paper presented at Annual Convention of Association of Iron and Steel Electrical Engineers.

The above-mentioned tunnel is good only for short distances, and where the cables are connecting heavy and important loads and where it makes a convenient passage from station to station without interference. Where the distance is reasonably great, the conduit system is by far the cheapest and the best.

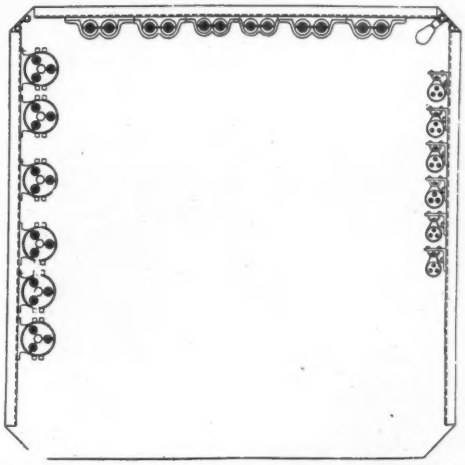


FIG. 2. SECTION THROUGH CABLE TUNNEL USED IN STEEL MILL WORK

Running cables underground is a scheme originated in the early '80's when Edison devised a system of underground feeders, consisting of a copper conductor placed inside of an iron pipe, the pipe being then filled with insulating compound; the pipes were joined at their ends by cast-iron boxes and the copper conductors

FIG. 3. ARRANGEMENT OF CABLES AND METHOD OF SUPPORT EMPLOYED IN UNDERGROUND TUNNEL

were connected to each other by flexible links in the boxes, the boxes being afterwards filled with compound and a cover plate bolted on.

This combination of conduit and conductors was then buried in the ground and formed the first underground system in this country—but did not prove of great value, as it gave considerable trouble and was extremely

expensive to keep up. The steel pipe construction was then abandoned and conduits of wood and vitrified clay substituted, and afterward fiber duct came into existence.

Underground systems now are generally constructed of vitrified duct, either in single conduit or multiple conduit as shown in Fig. 4; of fiber duct, Fig. 5, or sometimes of concrete.

Vitrified duct has many characteristics which make it less desirable for distribution systems; the sections are short, making many joints, and thus it is harder to line up properly and is more liable to leakage; the inside of the duct is apt to have burrs which will injure the lead casing of the cable; and the material of which the ducts are constructed is heavy and requires careful handling to prevent large amounts of breakage. This

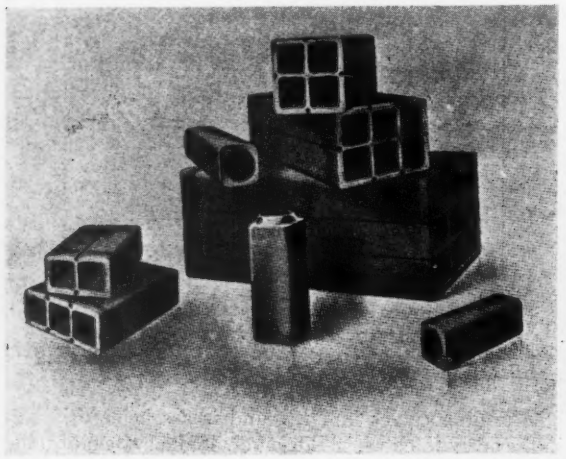


FIG. 4. SINGLE AND MULTIPLE CONDUIT VITRIFIED DUCT

vitrified duct also melts under short circuits, sometimes causing injury to other cables or so destroying the duct as to render it unfit for use again unless expensive repairs are made to it.

Fiber duct seems to have much better qualifications for underground transmission. It is made in lengths of 4 to 5 ft., is extremely light and reasonably tough, so that it can stand rough usage well; has fewer joints and is, therefore, easier to line up and also to waterproof; has high insulating qualities and is smooth on the inside, thus making cable pulling easy and safe. As for its fire resisting qualities, it will burn under prolonged arcing, but the burnt part, at worst, can be cleaned out leaving a concrete duct ready to receive the cable. Under ordinary arcing, however, it shows little sign of distress.

Concrete ducts have the greatest arc resisting qualities, but are expensive to make, hard to waterproof and tend to wear the cable sheath while pulling in.

Selection of Duct

In choosing the duct to be used for a given underground system, ducts should be provided large enough to take care of these cables—some engineers recommend using a duct ½ in. larger than the outer diameter of the cable. This may be sufficient in some cases, but in the event of using many different size cables, there would have to be many different ducts that could be used only for these sizes of cables; therefore, it is much better to use all ducts of the same size adopting the largest ones which are about 4 in. internal diameter. In this way in laying out spare conduits, we would be able to take care of any cable required.

As to the number of ducts in one group, there is a difference of opinion. It is, however, advisable to use as few ducts as possible in the same group, not over 12 or 14 ducts being used; should more than that be necessary, then they should be divided into two groups with earth between them.

As to the number of ducts to be used for a given system, account must be taken of future extension. Probably the simplest way is to allow two ducts more than actually needed, then double that number. Should a large number of cables leave the power station, they should be distributed over the different routes in order to keep the number of conduits in each line of conduit down to a minimum. Figure 6 shows a typical conduit system.

Manholes

Next in importance to the ducts are the manholes; these can be constructed either of bricks or concrete.

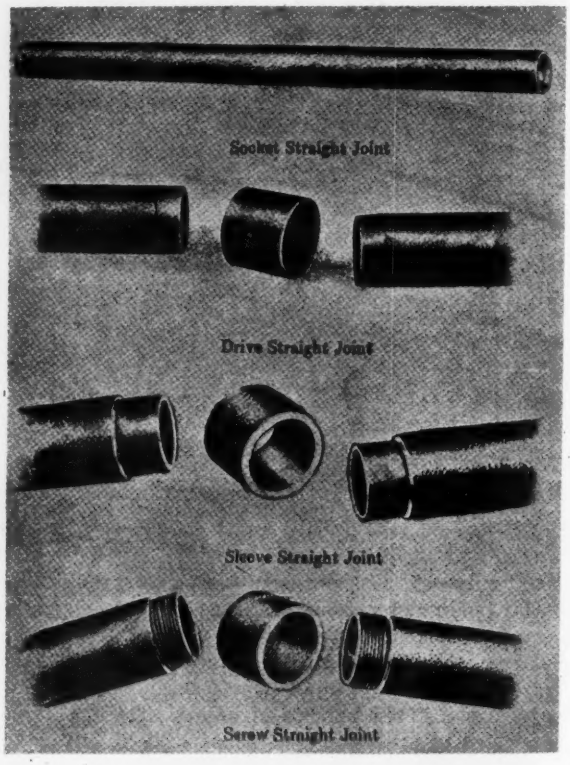


FIG. 5. FIBER DUCT AND FITTINGS

The concrete manholes are to be preferred to those of brick, being cheaper to build and easier to waterproof. They should be of sufficient size to allow of laying the cables along the side walls, and for convenience of work such as drawing-in and splicing, but should not be so large as to cause too sharp and pronounced bends in the cables when leading from duct to the wall. The following size manholes are approximately correct: for four-duct line, 6 by 6 ft.; for six to nine-duct line, 7 by

7 ft.; for twelve to sixteen-duct line, 8 by 8 ft.; all manholes should be from 6 to 7 ft. deep. Figure 7 shows two such manholes.

If paper or rubber insulated cables are to be used, special means will have to be provided for the protection of these cables against fire, but where varnish cambric cables are used, supports only need be provided in case of emergency, and should be equipped with trap for preventing the entrance of sewer gas into the manhole—as shown in Fig. 7.

The ducts should enter the manhole at right angles to the side wall, and the inside ends should be carefully rounded off to protect the cable against injury when pulling in or bending.

In manholes into which rubber or paper insulated cables are led, the ends of the ducts should be sealed around the cables to prevent the gases, formed by the burning of the insulation, from going into the manhole and spreading the fire to adjacent cables and even sometimes causing a serious explosion.

Cable Consideration

The next item to be taken into consideration in underground distribution, is the type and size of cables to be used.

In steel mills and industrial plants, where the distances are not great and the use of high voltage not necessary, 6600 to 13,200 v. will be found high enough to take care of even large installations. There are three types of standard cables used: paper, rubber and varnished cambric insulated. Paper insulated cable has been

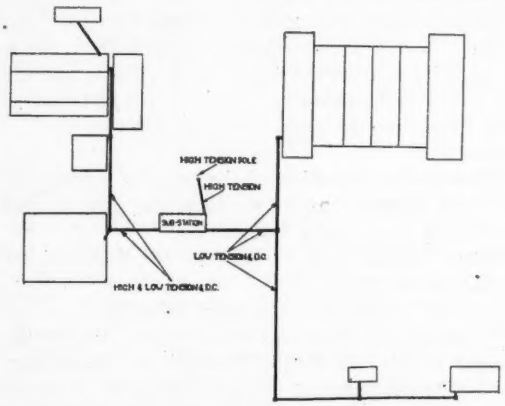


FIG. 6. TYPICAL STEEL MILL CONDUIT SYSTEM

adopted by practically all large operating companies for underground service, principally on account of its low cost, and its ability to withstand working temperatures found in conduit systems without serious deterioration of the insulation. In the case of large installations, costs may be reduced to a minimum by the use of paper insulated cable due to the fact that it is cheaper than either rubber or varnish cambric insulated. This paper insulation, however, being hygroscopic, absorbs moisture readily from the air, and therefore, has to depend entirely on the continuity of its lead sheath, as any small hole or break in the sheath is quickly followed by a breakdown. Although this may not be serious in the case where large systems are interconnected, but in the case of steel mills or industrial plants where it is essential that continuity of service be maintained, there is no question but that paper insulated cables are not suited for underground installations.

Rubber insulated cable should not be used, as the insulation suffers constant deterioration when operating in conduit, due to constant heating and its life becomes, therefore, questionable.

Varnished cambric cable has long since passed the experimental stage, having been in use for about 20 yr. with satisfactory results. During this time, the insulation has been constantly improved so that the present cable is far superior to that originally produced.

Varnished cambric cables are somewhat cheaper in first cost than rubber and they possess all the advantages of rubber with none of the disadvantages. With rubber insulation, it is difficult to keep the conductor central

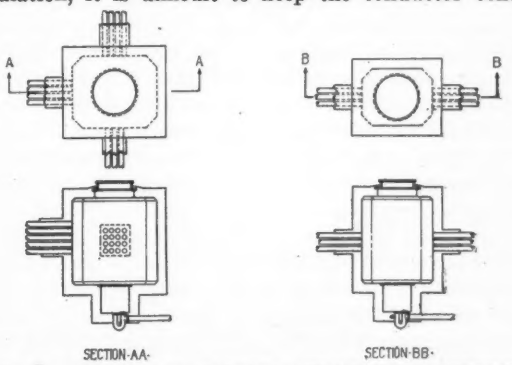


FIG. 7. PLANS AND SECTIONS THROUGH WATERPROOF MANHOLES

in the insulation and also to avoid defects where the thickness of the insulation is considerable. The varnished cambric is applied in the form of tape and a plastic compound is used between the tapes to seal up any slight mechanical faults to prevent the insulation from drying out, and to exclude air and moisture between the tapes. The compound also acts as a lubricant, so that the tapes will slide one on the other when the cable is bent.

The conclusion can therefore be reached, that for plants where continuity of service is all important varnished cambric is by far the best and, therefore, the cheapest insulation for underground work.

As to the size of the cables, this is governed principally by the heating which depends largely upon the class of service—either continuous or intermittent; the kind of ducts used and their spacing; and the qualities of the soil into which the ducts are laid.

For all practical purposes, the best method to follow is to consult a cable manufacturer's list and select the cable that is supposed to carry the desired current at a safe temperature and use the next larger size.

Large size cables, however, should be avoided—nothing larger than 500,000 c.m. being used; and where the load is too large two or more smaller cables should preferably be used, especially as in case of a breakdown in one cable a part of the service can still be maintained in the remaining cable or cables as the case may be.

Good health, imagination, persistency, and a good memory—and of course keeping everlastingly at it—are the principal requisites for a successful career.—Samuel Insull.

An Invention that Brought the World Together---II

"My God—It Talks" from the Emperor Was the Announcement to the World That the Telephone Was Born. By F. H. Sweet

BELL had not been forgetful of "Visible Speech" all this while, but had been making experiments with two remarkable machines—the phonautograph and the manometric capsule, by means of which the vibrations of sound were made plainly visible. If these could be improved, he thought, then the deaf might be taught to speak by *sight*—by learning an alphabet of vibrations. He mentioned these experiments to a Boston friend—Dr. Clarence J. Blake; and he, being a surgeon and an aurist, naturally said: "Why don't you use a *real ear?*"

Such an idea never had, and probably never could, have occurred to Bell; but he accepted it with eagerness. Dr. Blake cut an ear from a dead man's head, together with the ear-drum and the associated bones. Bell took this fragment of a skull and arranged it so that a straw touched the ear-drum at one end and a piece of moving smoked glass at the other. Thus, when Bell spoke loudly into the ear, the vibrations of the drum made tiny markings upon the glass.

It was one of the most extraordinary incidents in the whole history of the telephone. To an uninitiated onlooker nothing could have been more ghastly or absurd. How could anyone have interpreted the gruesome joy of this young professor with the pale face and the black eyes, who stood earnestly singing, whispering, and shouting into a dead man's ear? What sort of a wizard must he be, or ghoul, or madman? And in Salem, too, the home of the witchcraft superstition! Certainly it would not have gone well with Bell had he lived two centuries earlier and been caught at such black magic.

What had this dead man's ear to do with the invention of the telephone? Much. Bell noticed how small and thin was the ear-drum, and yet how effectively it could send thrills and vibrations through heavy bones. "If this tiny disk can vibrate a bone," he thought, "then an iron disk might vibrate an iron rod, or at least an iron wire." In a flash, the conception of a membrane telephone was pictured in his mind. He saw in imagination two iron disks, or ear-drums, far apart and connected by an electric wire, catching the vibrations of sound at one end, and reproducing them at the other. At least he was on the right path, and had a theoretical knowledge of what a speaking telephone ought to be. What remained to be done was to construct such a machine and find out how the electric current could best be brought into harness.

Then, as if Fortune suddenly felt that he was winning this stupendous success too easily, Bell was flung back by an avalanche of troubles. Sanders and Hubbard, who had been paying the cost of his experiments, abruptly announced that they would pay no more unless he confined his attention to the musical telegraph, and stopped wasting his time on ear-toys that never could be of any financial value. What these two men asked could scarcely be denied, as one of them was his best-paying patron and the other was the father of the girl whom he hoped to marry.

"If you wish my daughter," said Hubbard, "you must abandon your foolish telephone."

Bell's "School of Vocal Physiology," too, from which he had hoped so much, had come to an inglorious end. He had been too much absorbed in his experiments to sustain it. His professorship had been given up, and he had no pupils except Georgie Sanders and Mabel Hubbard. He was poor, much poorer than his associates knew; and his mind was torn and distracted by the contrary calls of science, poverty, business and affection.

Pouring out his sorrows in a letter to his mother, he said: "I am now beginning to realize the cares and anxieties of being an inventor. I have had to put off all pupils and classes, for flesh and blood could not stand much longer such a strain as I have had upon me."

While stumbling through this Slough of Despond, he was called to Washington by his patent lawyer. Not having enough money to pay the cost of such a journey, he borrowed the price of a return ticket from Sanders, and arranged to stay with a friend in Washington, to save a hotel bill that he could not afford. At that time, Professor Joseph Henry, who knew more of the theory of electrical science than any other American, was the Grand Old Man of Washington; and poor Bell, in his doubt and desperation, resolved to go to him for advice.

Then came a meeting which deserves to be historic. For an entire afternoon, the two men worked together over the apparatus that Bell had brought from Boston, just as Henry had worked over the telegraph before Bell was born. Henry was now a veteran of seventy-eight, with only three years remaining to his credit in the bank of Time, while Bell was twenty-eight. There was a long half century between them; but the youth had discovered a New Fact that the sage, in all his wisdom, had never known.

"You are in possession of the germ of a great invention," said Henry, "and I would advise you to work at it until you have made it complete."

"But," replied Bell, "I have not the electrical knowledge that is necessary."

"Get it," responded the aged scientist.

"I cannot tell you how much these two words encouraged me," said Bell afterward, in describing the interview to his parents. "I live too much in an atmosphere of discouragement for scientific pursuits; and such a chimerical idea as telegraphing *vocal sounds* would indeed seem to most minds scarcely feasible enough to spend time in working over."

By this time, Bell had moved his workshop from the cellar in Salem to 109 Court St., Boston, where he rented a room from Charles Williams, a manufacturer of electrical supplies. Thomas A. Watson was his assistant, and both Bell and Watson lived nearby, in two cheap little bedrooms. The rent of the workshop and bedrooms, and Watson's wages of nine dollars a week, were being paid by Sanders and Hubbard. Consequently, when Bell returned from Washington, he was compelled by his agreement to devote himself mainly to the musical telegraph, although his heart was now with the telephone. For three months after his interview with Professor Henry, he continued to plod ahead, along both lines,

until, on that memorable hot afternoon in June, 1875, the full *twang* of the clock-spring came over the wire, and the telephone was born.

From this moment, Bell was a man of one purpose. He won over Sanders and Hubbard. He converted Watson into an enthusiast. He forgot his musical telegraph, his "Visible Speech," his classes, his poverty. He threw aside a profession in which he was locally famous. And he grappled with this new mystery of electricity, as Henry had advised him to do, encouraging himself with the fact that Morse, who was only a painter, had mastered his electrical difficulties, and there was no reason why a professor of acoustics could not do as much.

The telephone was now in existence, but it was the youngest and feeblest thing in the nation. It had not yet spoken a word. It had to be taught, developed, and made fit for the service of the irritable business world. All manner of disks had to be tried, some smaller and thinner than a dime and others of steel boiler-plate, as heavy as the shield of Achilles. In all the books of electrical science, there was nothing to help Bell and Watson in this journey they were making through an unknown country. They were as chartless as Columbus had been in 1492. Neither they nor anyone else had acquired any experience in the rearing of a young telephone. No one knew what to do next.

For 40 weeks—long exasperating weeks—the telephone could do no more than gasp and make strange inarticulate noises. Its educators had not learned how to manage it. Then, on March 10, 1876, *it talked.* It said distinctly: *"Mr. Watson, come here, I want you."* Watson, who was at the lower end of the wire, in the basement, dropped the receiver and rushed with wild joy up three flights of stairs to tell the glad tidings to Bell. "I can hear you," he shouted breathlessly. "I can hear the *words.*"

It was not easy, of course, for the weak young telephone to make itself heard in that noisy workshop. Nobody, not even Bell and Watson, was familiar with its odd little voice. Usually Watson, who had a remarkably keen sense of hearing, did the listening; and Bell, who was a professional elocutionist, did the talking. Day by day, the tone of the baby instrument grew clearer—a new note in the orchestra of civilization.

On his twenty-ninth birthday, Bell received his patent, No. 174,465—"the most valuable single patent ever issued" in any country. He had created something so entirely new that there was no name for it in any of the world's languages. In describing it to the officials at the Patent Office, he was obliged to call it "an improvement in telegraphy," when, in truth, it was nothing of the kind. It was as different from the telegraph as the sign language of a deaf-mute is from the eloquence of a great orator.

Other inventors had worked from the standpoint of the telegraph; and they never did, and never could, get any better results than signs and symbols. But Bell worked from the standpoint of the human voice. He cross-fertilized the two sciences of acoustics and electricity. His study of "Visible Speech" had trained his mind so that he could mentally *see* the shape of a word as he spoke it. He knew what a spoken word was, and how it acted upon the air, or the ether, that carried its vibrations from the lips to the ear. He was a third generation specialist in the nature of speech, and he knew that for the transmission of spoken words there must be "a pulsatory action of the electric current which is the exact equivalent of the aerial impulses."

Bell knew just enough about electricity, and not too much. He did not know the possible from the impossible. "Had I known more about electricity, and less about sound," he said, "I would never have invented the telephone." What he had done was so amazing, so foolhardy, that no trained electrician could have thought of it. It was "the very hardihood of invention," and yet it had not in any sense been a chance discovery. It was the natural output of a mind that had been lead to assemble just the right materials for such a product.

As though the very stars in their courses were working for this young wizard with the talking wire, the Centennial Exposition in Philadelphia opened its doors exactly two months after the telephone had learned to talk. Here was a superb opportunity to let the wide world know what had been done, and fortunately Hubbard was one of the Centennial commissioners. By his influence, a small table was placed in the Department of Education, in a narrow space between a stairway and a wall, and on this table was deposited the first of the telephones.

Bell had no intention of going to the Centennial himself. He was too poor. Sanders and Hubbard had never done more than pay his room rent and the expenses of his experiments. For his three or four years of inventing, he had received nothing as yet—nothing but his patent. In order to live, he had been compelled to reorganize his classes in "Visible Speech," and to pick up the raveled ends of his neglected profession.

But one Friday afternoon, toward the end of June, his sweetheart, Mabel Hubbard, was taking the train for the Centennial; and he went to the depot to say goodbye. Here Miss Hubbard learned for the first time that Bell was not to go. She coaxed and pleaded without effect. Then, as the train was starting, leaving Bell on the platform, the affectionate young girl could no longer control her feelings and was overcome by a passion of tears. At this the susceptible Bell, like a true Sir Galahad, dashed after the moving train and sprang aboard, without ticket or baggage, oblivious of his classes and his poverty and of all else except this one maiden's distress. "I never saw a man," said Watson, "so much in love as Bell was."

As it happened, this impromptu trip to the Centennial proved to be one of the most timely acts of his life. On the following Sunday afternoon, the judges were to make a special tour of inspection, and Mr. Hubbard after much trouble, had obtained a promise that they would spend a few minutes examining Bell's telephone. By this time, it had been on exhibition for more than six weeks, without attracting the serious attention of anybody.

When Sunday afternoon arrived, Bell was at his little table, nervous, yet confident. But hour after hour went by, and the judges did not arrive. The day was intensely hot, and they had many wonders to examine. First was the electric light, and the first grain binder, and the musical telegraph of Elisha Gray, and the marvelous exhibit of printing telegraphs shown by the Western Union Company. By the time they came to Bell's

table, through a litter of school desks and blackboards, the hour was seven o'clock, and every man in the party was hot, tired and hungry. Several announced their intention of returning to their hotels. One took up a telephone receiver, looked at it blankly, and put it down again. He did not even place it to his ear. Another judge made a slighting remark which raised a laugh at Bell's expense. Then a most marvelous thing happened —such an incident as would make a chapter in "The Arabian Nights entertainments."

Accompanied by his wife, the Empress Theresa, and by a bevy of courtiers, the Emperor of Brazil, Dom Pedro de Alcantara, walked into the room, advanced with both hands outstretched to the bewildered Bell, and exclaimed, "Professor Bell, I am delighted to see you again."

The judges at once forgot the heat and the fatigue and the hunger. Who was this young inventor, with the pale complexion and the black eyes, that he should be the friend of emperors? They did not know, and for the moment even Bell himself had forgotten, that Dom Pedro had once visited Bell's class of deaf-mutes at Boston University. He was especially interested in such humanitarian work, and had recently helped to organize the first Brazilian school for deaf-mutes at Rio de Janeiro. And so, with the tall, blond-bearded Dom Pedro in the center, the assembled judges and scientists —there were fully fifty in all—entered with unusual zest into the proceedings of this first telephone matinee.

A wire had been strung from one end of the room to the other, and while Bell went to the transmitter, Dom Pedro took up the receiver and placed it to his ear. It was a moment of tense expectancy. No one knew clearly what was about to happen, when the Emperor, with a dramatic gesture, raised his head from the receiver and exclaimed with a look of amazement: "My God—it talks!"

Next came to the receiver the oldest scientist in the group, the venerable Joseph Henry, whose encouragement to Bell had been so timely. He stopped to listen, and, as one of the bystanders afterward said, nobody could forget the look of awe that came into his face as he heard the iron disk talking with a human voice. "This," said he, "comes nearer to overthrowing the doctrine of the conservation of energy than anything I ever saw."

Then came William Thomson, later known as Lord Kelvin. It was fitting that he should have been there, for he was the foremost electrical scientist at that time in the world, and had been engineer of the first Atlantic Cable. He listened, then had his wife placed at the other end of the wire, to be sure, and learned what even he had not known before, that a solid metallic body could take up from the air all the countless varieties of vibrations produced by speech, and that these vibrations could be carried along a wire and reproduced exactly by a second metallic body. He nodded his head solemnly as he rose from the receiver. "It *does* speak," he said emphatically. "It is the most wonderful thing I have seen in America."

So, one after another, this notable company of men listened to the voice of the first telephone, and the more they knew of science, the less they were inclined to believe their ears. The wiser they were, the more they wondered. To Henry and Thomson, the masters of electrical magic, this instrument was as surprising as it was to the man in the street; and both were noble enough to admit frankly their astonishment in the reports which they made as judges, when they gave Bell a Certificate of Award. "Mr. Bell has achieved a result of transcendent scientific interest," wrote William Thomson. "I heard it speak distinctly several sentences. I was astonished and delighted. It is the greatest marvel hitherto achieved by the electric telegraph."

Until nearly 10 o'clock that night, the judges talked and listened by turns at the telephone. Then, next morning, they brought the apparatus to the judges' pavilion, where for the remainder of the summer it was mobbed by judges and scientists. William Thomson and his wife ran back and forth between the two ends of the wire like a pair of delighted children. Thus it happened that the crude little instrument that had been tossed into an out-of-the-way corner became the star of the Centennial. It had been given no more than 18 words in the official catalog, and here it was acclaimed as the wonder of wonders. It had been conceived in a cellar and born in a machine shop; and now, of all the gifts that our young American Republic had received on its one-hundredth birthday, the telephone had been honored as the rarest and most welcome of them all.

DEVELOPMENT OF her water power under plans now being carried out will make France third among the nations who lead in this respect. The report of the Commission des Forces Hydraulique shows that in round figures the water power in France may be reckoned theoretically at about 9,000,000 hp. Of this amount 1,165,000 hp. is in use. About 500,000 hp. additional is being equipped. In about 15 yr. 6,000,000 hp. more should be realized. The rest remains available for eventual development. The plants in course of construction will provide 550,000 hp.

The region of the southeast of France is the best developed thus far, with 750,000 hp. already installed and with 290,000 hp. in the course of installation. The southwest has 210,000 hp. and will have 75,000 more in a short time. The central section has 140,000 hp. and is making plans for an additional 125,000 hp. The eastern district expects to increase its 25,000 to 35,000. Existing plans are to provide the 3,000,000 hp. additional of the program inside the 15 yr. Of this total 1,200,000 hp. will be in the southeast, 500,000 in the southwest, 40,000 in the center and 62,000 in the east.

U. S. CIVIL SERVICE COMMISSION announces examinations for Senior Engineer, Grade 2, civil, electrical, mechanical, signal, structural, telegraph, and telephone senior architect to fill vacancies in the Interstate Commerce Commission, under the act providing for the valuation of the property of common carriers, at $2100 to $2700 a year, and vacancies in positions requiring similar qualifications, at these or higher or lower entrance salaries. Applicants must have reached their twenty-fifth but not their fiftieth birthday on the date of the examination. Age limits do not apply to persons entitled to preference because of military or naval service. Apply for Form 1312, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.

Saving Fuel by Controlling Chimney Losses*

CAUSES OF LOSSES IN FLUE GASES AND METHODS OF DETECTION. BY F. F. UEHLING†

NO MATTER how the fuel we use is consumed and no matter what kind of fuel is burned, whether solid, powdered, liquid or gaseous, the biggest loss is always due to the heat energy wasted up the chimney. In this connection, it might be well to quote the following very conservative statement from Technical Paper No. 205, issued by the Bureau of Mines:

"In the average boiler plant, 35 per cent of the heat in the coal burned under the boilers is lost with the stack gases. It is this loss that can be greatly reduced and every effort should be made to do so."

The loss up the chimney, which is always the largest individual loss in any plant, depends for its magnitude on three factors. They are, in order of importance: first, excess air in the products of combustion; second, temperature of the products of combustion; third, amount of unconsumed fuel in the products of combustion.

GREATEST LOSS DUE TO USING TOO MUCH AIR

EXCESS AIR in the products of combustion results in a loss greater than that from any other source. Each kind of fuel requires a definite amount of air to burn it, the exact quantity depending principally upon the ratio of its carbon and hydrogen. When considering coal, for example, the principal constituent is carbon, every pound of which requires 12 lb. of air completely to consume or oxidize it. All air that is used above this amount is known as excess air, and when supplied in greater quantities than is necessary to meet the particular conditions of the furnace in which the fuel is burned, an unnecessary burden is immediately placed on the temperature possibilities of the furnace and the amount of fuel consumed to accomplish a desired result increases in proportion. Although air costs nothing, and is available in unlimited quantities, when used to burn fuel in excess of what is required, as is the case in the average plant, it becomes one of the most expensive raw materials.

All the air that is used in burning fuel appears in the products of combustion. If three times as much air is used as is necessary there will be just three times as much products of combustion as necessary. This gas as it passes up the chimney contains the major portion of the heat that is unnecessarily wasted. The exact amount of heat wasted in this way can be determined by the weight of the products of combustion per pound of fuel burned, and the temperature at which they leave the furnace or enter the stack. Thus, in the average plant, from one-third to one-half of the heat contained in the fuel is stolen by the products of combustion and dissipated into the atmosphere.

SMOKE NOT NECESSARILY A SIGN OF WASTE

LOSS UP the chimney due to unconsumed fuel in the products of combustion, is usually not so serious. The old idea that a smoky stack is a sign of tremendous waste is not always true, in fact, whether the gases leaving a chimney are smoky or smokeless is no indication at all as to the efficiency with which the fuel is consumed. Steam boilers, for example, connected with a stack that does not show the slightest trace of smoke may burn twice as much coal per pound of steam generated as when smoke is in great prominence.

Black smoke is, of course, unburned carbon, but the amount of carbon in this light and finely divided form

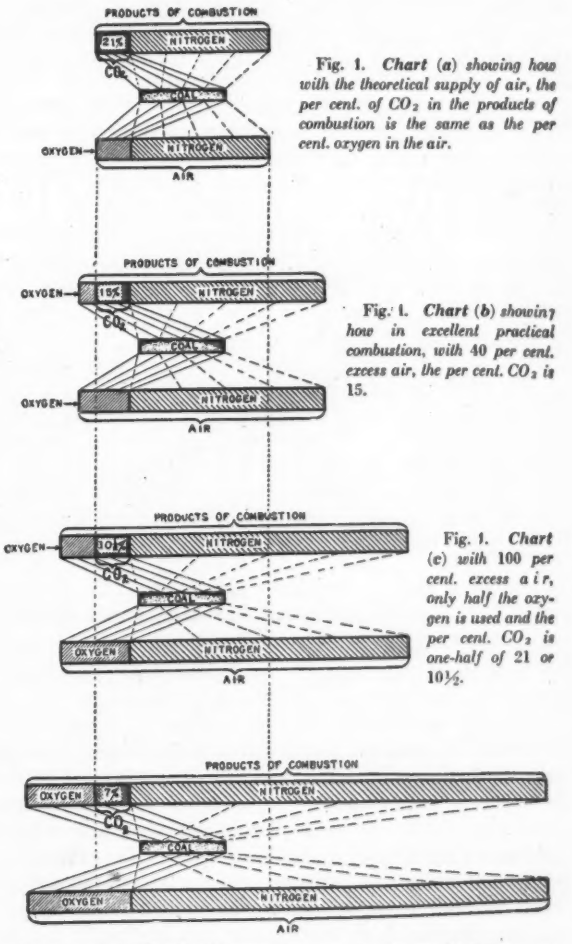


Fig. 1. *Chart (a) showing how with the theoretical supply of air, the per cent. of CO_2 in the products of combustion is the same as the per cent. oxygen in the air.*

Fig. 1. *Chart (b) showing how in excellent practical combustion, with 40 per cent. excess air, the per cent. CO_2 is 15.*

Fig. 1. *Chart (c) with 100 per cent. excess air, only half the oxygen is used and the per cent. CO_2 is one-half of 21 or 10½.*

Fig. 1. *Chart (d) with 200 per cent. excess air, only one-third the oxygen supplied is needed and the per cent. of CO_2 is one-third of 21 or 7 per cent.*

FIG. 1. DIAGRAMMATIC RELATION OF PER CENT CO_2 IN FLUE GASES TO EXCESS AIR

that is necessary to give the products of combustion a dark or even a black appearance is generally only a small fraction of one per cent of the actual fuel burned. The additional unconsumed fuel that is apt to be present in the products of combustion is carbon monoxide and hydrocarbons, both of which are caused by an insufficient air supply or the improper mixture of the air with the fuel before it is ignited. Although it is possible for the loss due to this cause to be serious, it is a fact

*Abstract of paper read before Fuel Section of the Sixth National Exposition of Chemical Industries.

†Combustion engineer for Uehling Instrument Co.

that the average loss from this source can safely be estimated at less than 2 per cent.

Instruments Detect Chimney Losses

To minimize chimney losses, no matter what means are used, we must know whether or not the proper amount of air is being supplied, whether or not air is mixed with the fuel before it is ignited, and whether or not too much heat is left in the products of combustion as they pass up the chimney. Under all conditions these important facts can be determined by consistent flue gas analyses and temperature measurements.

In ninety-nine cases out of a hundred, excessive loss of heat up the chimney is simply due to lack of facilities for determining whether the proper amount of air is supplied. When carbon, the principal constituent of any fuel, is completely burned the result is carbon dioxide (CO_2). Complete combustion occurs when air is

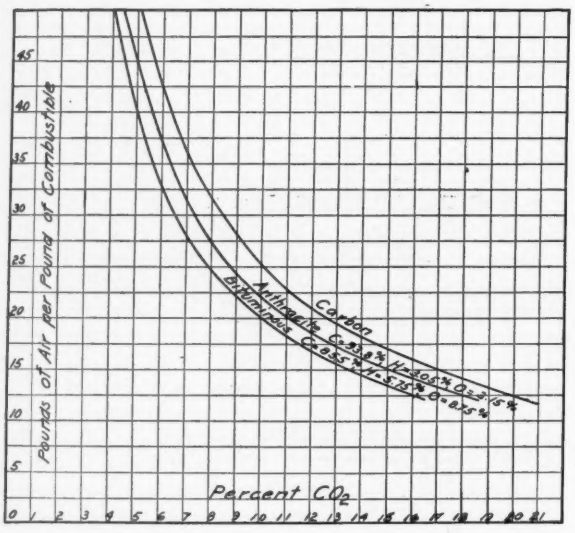


FIG. 2. RELATION OF PER CENT CO_2 AND POUNDS OF AIR PER POUND OF CARBON, OF ANTHRACITE COMBUSTIBLE AND OF BITUMINOUS COMBUSTIBLE

supplied in excess of what is needed. When, however, the air supply is reduced too much so that it is little more than that which is theoretically required, there is also a possibility of incomplete combustion due to an insufficient amount of air reaching part of the combustible. When this is the case, some of the carbon in the fuel will become only half oxidized, that is, it will burn to carbon monoxide (CO) instead of to CO_2.

Carbon Dioxide in Flue Gases the Key to Wasteful Air Supply

It must be remembered, however, that the big loss in practice is due to excess air and not to an insufficient supply. In order clearly to illustrate the importance of this fact, let us consider carbon as the fuel we are burning. If 1 lb. of carbon were consumed with the exact amount of air required completely to burn it, the 21 per cent of oxygen in the air used would combine with it and appear as 21 per cent CO_2 in the products of combustion for the reason that oxygen combines with carbon to form an equal volume of CO_2.

On the other hand, if the same weight of carbon were consumed with twice the amount of air theoretically required to burn it, only one-half of the 21 per cent of oxygen in the air used would combine with the carbon, the volume of the products of combustion would be twice as much, and the CO_2 content only 10.5 per cent. Again, if the same weight of carbon were consumed with three times the theoretically required air, only one-third of the 21 per cent of oxygen in that air would combine with the carbon, the volume of the products of combustion would then be three times as great as theoretically necessary and the CO_2 content only 7 per cent.

It therefore follows that the lower the percentage of CO_2 in the products of combustion the greater will be the volume or weight of the flue gases per pound of fuel burned, and the greater the temperature of this gas as it leaves its zone of usefulness the greater will be the loss per unit of its weight. This is clearly illustrated in Fig. 1. In average steam boiler practice, for example, every pound of flue gas as it passes up the chimney is laden with sensible heat energy to the extent of from 100 to 200 heat units, and since there are from 25 to 30 or more tons of flue gas for every ton of fuel consumed, the magnitude of this tremendous loss can be readily appreciated. What it amounts to in actual heat units or in percentage of fuel used depends upon the percentage of CO_2 and the stack temperature. A table based on carbon as the fuel burned is shown herewith. Such a table can be prepared for any kind of fuel. With fuels such as oil, which are high in hydrocarbons, the maximum percentage of CO_2 obtainable would be less, but every 1 per cent drop in CO_2 would mean a greater increase in fuel wasted than a corresponding drop in CO_2 where a fuel richer in carbon is used. The percentage of CO_2 in the products of combustion is therefore an index to the amount of air used per pound of fuel burned, no matter what commercial fuel is utilized.

Several illustrations of this fact are shown in Fig. 2. Chimney losses can thus be controlled, at least to the extent which the particular design of furnace will permit, by the simple regulation of the air supplied, so that the weight of the products of combustion per pound of fuel burned will be reduced to a minimum. The two most important constituents of the products of combustion, for determination of flue gas analyses, are, therefore, the percentage of CO_2 and the percentage of CO. The former should be made continuously by means of a CO_2 recorder, while the latter determination is necessary only when the percentage of CO_2 is so high that an insufficient supply of air to all or part of the fuel is suspected.

Chimney losses, as previously stated, depend upon three factors: The amount of excess air in the products of combustion, which is determined by the percentage of CO_2; the amount of unburned fuel in the products of combustion, the magnitude of which is indicated by the percentage of CO; and the temperature of the products of combustion, which can be determined with an ordinary flue gas thermometer inserted in the last pass of the boiler furnace, just before the gas enters the stack.

Of these three determinations the percentage of CO_2 is by far the most important. The percentage of CO_2 is something the fireman can easily regulate. If the brick

setting of a furnace or of a boiler is made tight to prevent air infiltration it is an easy matter for him to decrease the excess air supply to 50 per cent or less by simple cut and try methods in the regulation of draft, thickness of firebed, etc., even though the excess air supply may have been 200 or 300 per cent before he attempted so to regulate combustion.

The determination of the percentage of CO, being generally of much less importance, need be made only when there is reason to believe that incomplete combustion exists. In fact, the majority of plants where CO_2 recorders are used, get remarkably good results, in so far as economy is concerned, without making CO determinations at all. In other plants, a series of tests are run for determining the maximum safe percentage of CO_2 without the formation of CO and the firemen are instructed to keep the CO_2 as near this point as possible without exceeding it. In many plants, however, the practice of merely instructing the firemen to keep the percentage of CO_2 as high as they can has led to surprisingly good results.

FIG. 3. HEAT CARRIED AWAY BY DRY CHIMNEY GASES PER POUND OF COMBUSTION*

POUNDS OF AIR PER POUND OF COMBUSTIBLE AND CORRESPONDING PERCENTS CO_2	TEMPERATURE OF CHIMNEY GASES, DEG. FAHR.							
LBS.	300°	350°	400°	450°	500°	550°	600°	650°
12	750†	905	1060	1216	1370	1528	1683	1840
21%	5.2‡	6.2	7.3	8.7	9.5	10.5	11.6	12.7
15	865	1112	1305	1498	1679	1880	2072	2262
16.8%	6	7.6	9.1	10.3	11.6	13.0	14.3	15.6
18	1004	1321	1550	1778	2010	2235	2460	2692
14.0%	7.2	9.1	10.7	12.2	13.9	15.4	17	17.9
21	1266	1530	1785	2060	2320	2582	2846	3118
12.0%	8.7	10.5	12.3	14.2	16	17.8	19.5	21
24	1440	1740	2040	2340	2640	2940	3240	3540
10.0%	9.9	12	14	16.1	18.2	20.3	22.4	24.4
27	1611	1950	2281	2620	2958	3291	3628	3962
9.3%	11.1	13.5	15.7	18.1	20.4	22.7	25	27.4
30	1785	2160	2530	2900	3270	3641	4016	4396
8.4%	12.4	14.9	17.4	20	22.6	25	27.8	30.4
33	1957	2362	2779	3180	3589	4000	4405	4820
7.6%	13.5	16.3	19.2	22	24.7	27.6	30.5	33.2
36	2130	2579	3020	3461	3910	4350	4798	5290
7.0%	14.7	17.8	20.8	23.9	27	30	33	36.6
39	2300	2781	3261	3743	4220	4700	5180	5670
6.5%	15.9	19.2	22.5	25.8	29.2	32.4	35.7	39
42	2479	2999	3508	4023	4540	5052	5570	6100
6.0%	17.1	20.6	24.7	27.7	31.3	34.8	39.4	42

* Gebhardt Steam Power Plant Engineering.
† Heat wasted in B. t. u.
‡ Heat wasted in per cent. of total heat in coal.

Low Temperature and Small Volume of Chimney Gases Desirable

The third variable, namely the temperature of the products of combustion as they enter the stack, is one over which the firemen have no control at all. This temperature should, of course, be kept as low as possible, but it depends entirely upon how much of the heat in the furnace is absorbed or utilized before the products of combustion make their final exit. In boiler practice, for example, stack temperature depends upon the area of the heating surface over which the hot gases pass and the cleanliness of the heating surfaces. The lower the stack temperature, the less will be the heat wasted; on the other hand, the higher the percentage of CO_2 the less will be the volume of flue gas to carry away valuable heat energy as it passes up the chimney. Since the temperature of the products of combustion does not vary materially during short intervals of time, the percentage of CO_2 by itself becomes a most reliable index to the greatest loss of all—the sensible heat energy wasted up the chimney.

A Real Tribute to Labor

By J. B. Dillon

From time to time, prizes have been offered by various concerns to people who would write the best letter on the subject, "What would you do if you had a million dollars thrust upon you?"

No doubt, many of the letters written were honest ones—as far as the writers felt—but then they did not have the money, nor any reason to believe that they ever would have, therefore the "psychological moment" was missing, and quite likely just what their real actions would be if the thing was enacted was left unchronicled.

All of this is different in the case of James Yarborough, a section foreman on the St. Louis & San Francisco Railway, in Oklahoma. He got the money and here is what he is doing with it: Establishing a school for young men so that after graduation they will come out as first class section foremen; it has long been a hobby of Yarborough to admire a good section foreman. If this is a forerunner of some of the good things he is going to do with the money, nobody need worry lest any of it will be misapplied.

Incidentally, has not Yarborough emphasized the fact that the best work one can do is none too good and that labor is honorable? And although he has his millions, he might prefer being a first class section foreman.

Loss of Coal Products

In a statement by Joseph E. Pogue, issued by the Fuel Section of the A. S. M. E., attention is focused on the loss of byproducts, benzol, tar, ammonia and gas from burning bituminous coal in small plants for dwellings and factories. The loss is estimated at $1,000,000,000 a year from these products lost in black smoke, with twice that amount of damage to property and health.

Mr. Pogue advocates the establishment of municipal plants and plants at mine mouth to reclaim these byproducts by distillation, and furnish smokeless fuel as a residue. The byproducts will be of good value in paving roads, fertilizing fields and as fuel for internal combustion engines, and the damage from black smoke will be avoided.

The United States weather bureau and forest service have cleared 200 acres of heavily timbered land at Wagon Wheel Gap in the southwestern part of Colorado, the purpose being to contrast the effect on the water flow of barren land with that formerly timbered.

A year will be necessary to determine the facts. Those interested might make a note of this and ask for a report.

J. B. Dillon.

Electric Power at Oshkosh, Wisconsin

(Continued from page 1161)

the turbine room basement above the superheated main with a riser along the boiler room wall through the roof. All auxiliaries exhaust into a line, shown in Fig. 10, running under the basement floor in both boiler and turbine rooms and connecting to a riser which leads to the feed-water heater.

Back of the boilers in the basement is a blowoff main with connections to boilers and economizers. It is suspended, as is all basement piping except the superheat header and the exhaust in the ash room, from the floor above on roller hangers, and is anchored at only one point to allow free expansion. Blowoff is discharged into the river, with a check valve at the outlet to prevent water being drawn in by condensation of steam, which would result in water hammer.

All piping is covered with asbestos sponge felted insulation, 3 in. thick on superheated lines, 2 in. on saturated lines, and 1 in. on exhaust and feed water lines and on drips and drains. In addition to the regular jacket

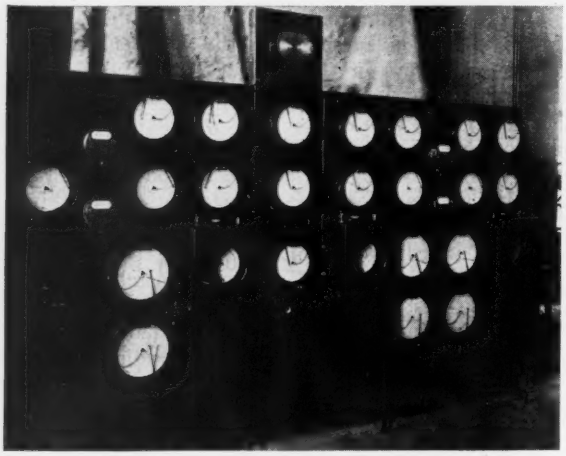


FIG. 12. BOILER ROOM CONTROL BOARD

all lines have an additional 8-oz. canvas jacket sewed on. All drip from steam lines is returned to the soft water settling tank. Cold water lines are covered with less expensive insulation to prevent drip from condensation. Various services are denoted by the color of the paint on coverings, superheat being yellow, saturated steam white, feed water white with blue fittings, high-pressure water blue, low-pressure water black and atmospheric exhaust tan color.

Boiler Room Control Board.

THIS BOARD, shown in Fig. 12, is a most complete installation and gives means for knowing the operating conditions of the steam plant at all times and for comparing present with past performance. It is provided, for each boiler, with recording and indicating steam flow meter, double pen recorder for pressure in ash pit and draft over fire, double pen recorder for draft over fire and in uptake, double pen recorder for flue gas temperature of water entering and leaving economizer, recorder for boiler pressure and another for temperature of steam leaving superheater, continuous recorder for CO_2. Near the feed-water heater is also a gage board with double pen recorder for temperature of water entering and leaving the heater, and a steam flow meter recording the flow of steam to the gas works. Records are filed each morning with the chief engineer.

As an indication of the operating conditions, the following readings were taken on a recent visit to the plant:

No. 3 boiler. Steam pressure, 210 lb.; final temperature of steam, 560 deg.; feed water to heater, 70 deg.; from heater, 150 deg.; from economizer, 250 deg.; gas temperature to economizer, 420 deg.; from economizer, 305 deg.; ash pit pressure, 2.8 in.; draft over fire, 0.05 in.; CO_2, 12 per cent; flow meter, 32,000 lb. per hr.

Generating Units.

PRESENT equipment includes a 700-kw. unit transferred from the old plant and rewound, a 1250-kw. unit and a 3000-kw. unit all rating at 80 per cent power factor and each with its Le Blanc condenser; all generate current of 60 cycles at 4000 v. and feed directly to the bus bars.

The units are known as Nos. 2, 3 and 4, space being left for No. 1, a future 5000-kw. unit in the end of the room nearest the river. Jet condensers were selected because of the great cost of surface condensers and the difficulty of getting delivery on surface condensers at the time installation was made; but for the 5000-kw. unit, a surface condenser will undoubtedly be used.

All generators are air cooled, the air being taken from the outside through a main duct of cement plaster on wire lath, Fig. 13, with galvanized iron branches to the various machines. At present, cloth screens are used in the air intake, but provision has been made for installing an air washer if it should be required later.

Foundations are supported independent of the building on piles, of beam and column type reinforced concrete to give maximum room for machinery below. The construction is shown in Fig. 13, which also shows the turbine for driving the condenser pump and the discharge pipes. The condenser is hidden behind the post in the front center. Foundations for condensers and pumps all rest directly on the basement floor.

To furnish exciting current, one motor-driven exciter, 25 kw. and one steam-driven, 50 kw., are used, the former being taken from the old plant. They are rated at 125 v. Locations and conduits have been provided to install future exciter units as they are needed.

Headroom and rails have been provided for a 40-t. motor-driven crane, looking to the time when larger units will be in use, but at present a 15-t. hand-operated crane is installed.

The two larger units were bought new and were wound and connected for 4000 v., 3-phase, 4-wire, with neutral points connected to the station ground bus bar. The 700-kw. unit from the old plant had to be rewound, as it was formerly 2300-v., 3-phase, 3-wire, star connected. The rating was originally 500 kw.; but it was desired, in rewinding, to put on coils to give the largest possible capacity. The slot space allowed of using the coils and insulation which apparently would care for 700 kw.; but as the capacity would be limited by the heating of the field rotor at loads above rating, the manufacturers would not guarantee capacity with the

new coils, above the original. Field winding had recently been reinsulated with a covering for resisting high temperature, so search coils for indicating the temperature of the windings were installed and connected to indicators on the switchboard, and load is carried according to the temperature shown by these indicators. This unit was also furnished with a synchronizing motor and a motor-operated head provided for the field rheostat so that it could be controlled from the bench board.

Exciters.

Another change was reconnecting the motor of the exciter unit from 220 v. to 440 v., the service voltage in the new plant.

All operation of high tension connections and of exciter units is from the bench board through remote control switches, except that the equalizer switches for exciters are directly at the exciters and on each equalizer switch panel is an auxiliary switch through which current must pass for operating the main exciter circuit breaker. It is, therefore, impossible to close an exciter onto the bus unless the equalizer is first closed. Starting of the exciter motor which is from half voltage taps on the station transformers is by remote control on the bench board, with relays to trip out the running switch automatically in case of overload. The exciter main switches, also controlled from the bench board, are circuit breakers connecting to the exciter bus bars.

Current Control.

Control of exciter voltage is by rheostats mounted on the rear of the bench board apron, operated by concentric handles, one for the main rheostats and the other for the equalizer rheostat in the exciter field circuit, used in connection with the Tirrill regulator when running exciters in parallel.

Generators are also controlled from the bench board, which has three sections; the center section is arranged for controlling four exciters, the two now in use and two futures. Also in this section is the oil switch control for transformers supplying station power, and instruments for the station supply circuit. Each of the outer sections is arranged to control three generators with grooves in the slabs marking them into three parts, thus indicating the control of each generator. No field ammeters are provided for generators, but division of load when running in parallel is determined by power factor meters, one for each generator and a temperature indicator is provided to indicate temperature of windings. Control of commercial circuits is from vertical switchboards at the sides of the bench board, on the right for power and on the left for lighting. The power board controls three commercial and one railway circuits, each with an ammeter and an overload relay in each phase, a remote control coil switch and watt-hour meter. There are four lighting circuits on the left hand board, equipped with separate switches for each phase of each circuit to minimize outages in case of trouble on the lines.

The railway circuits are controlled from a special board, in the rear of the bench board. The rotary converter is located under the gallery and is seen behind the column at the right of Fig. 9. It furnishes power to the Eastern Wisconsin Electric Co. for the street railways in Oshkosh, and the line to Fond-du-lac and Neenah. The converter is of 750 kw. capacity, the a.c. side taking current from 6 rings at 212 v. between rings and the d.c. delivering at 600 v. with capacity of 1250 amp.; the d.c. leads have a set of load limiting resistors which are automatically cut in at a predetermined load, thus limiting the maximum demand from the railway circuit.

Starting of the converter is accomplished by a three-pole, double-throw switch at the machine for the a.c. side. The d.c. brushes are protected by flash guards to prevent shorting around the commutator. The railway switchboard consists of three feeder circuit panels, a d.c. rotary panel and a panel containing contact making ammeters for controlling the automatic d.c. overload equipment each with an ammeter, and a single pole switch with spark-gap quick break attachment. To control the machine is a panel with circuit breaker, ammeter, single-throw switch, voltmeter switch and rheostat; and the right hand panel for the a.c. side of the machine has an ammeter for each phase, a three-pole switch, a two-pole field switch and three a.c. contactors.

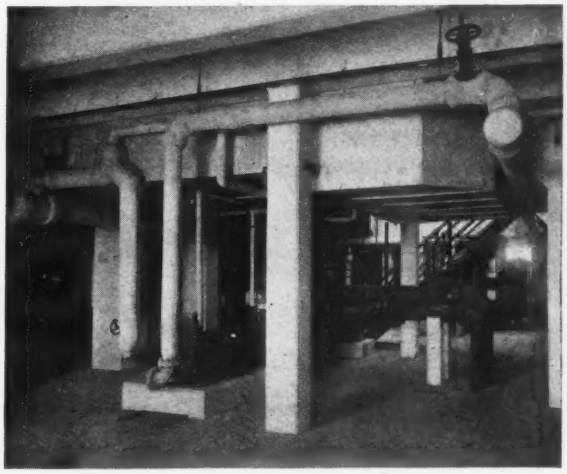


FIG. 13. VIEW IN BASEMENT OF TURBINE ROOM

Current is taken from the railway station of the 4000-v. bus to a set of transformers in the basement, there stepped down and delivered to the converter. The converter feeds the d.c. bus back of the railway switchboard from which the outgoing feeder cables run underground beneath the Chicago and Northwestern R. R. tracks. They are brought up to a pole line and connect to the trolley circuits and to feeders for distant points.

Street Lighting.

Street lights are 6.6-amp. constant current Mazda lamps arranged on five circuits, and are supplied from tub transformers through panels on the main floor under the north end of the gallery. Two transformers of 60 kw. each at 2200 v. handle two circuits each, and the fifth is supplied by a 30-kw. transformer. Telltale lamps, two in a series are kept connected through the day on each circuit to give warning of any open circuit and permit immediate repair. This equipment was transferred from the old plant.

Station Power.

Power for station use is supplied by three 100-kv.a. transformers in the basement, fed from the main 4000-v.

bus and delivered at 440 v. to the main station panel in the basement. This panel distributes to the motors on the condenser circulating pumps, which are also arranged for steam drive and to a distributing panel in the boiler room basement, which supplies the coal handling equipment and pump motors and also distributes to a panel supplying motors for economizer fans and scrapers, and to the single-phase motors which operate feed for the automatic coal scales. There is also provision for a circuit to operate the motor for the future traveling screen at the intake screen house.

All large motors are three-phase and are provided with auto-starters having overload and low voltage re-

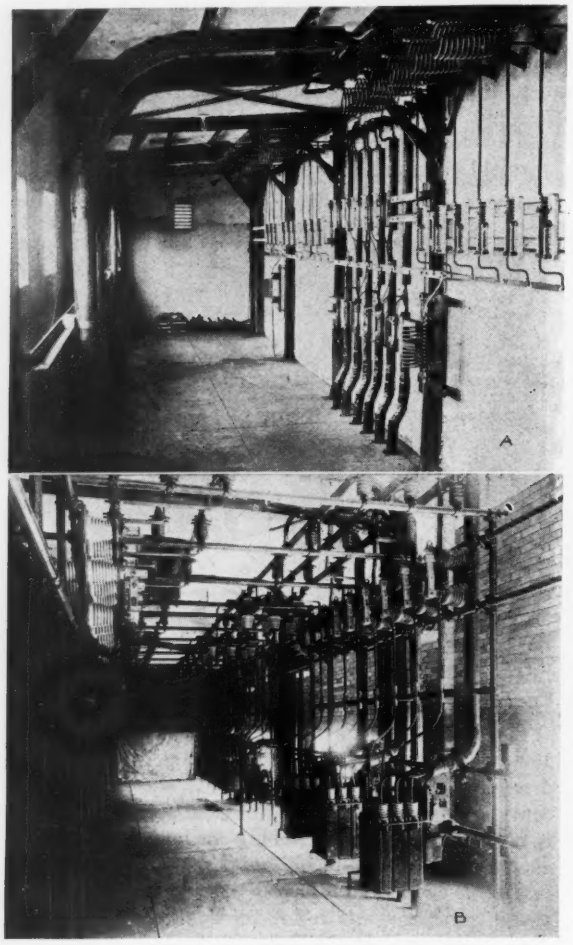


FIG. 14. FEEDER BUS COMPARTMENT IN SECOND GALLERY
FIG. 16. INTERIOR OF PENTHOUSE, SHOWING LIGHTNING ARRESTERS, OUTLET TO LINE AND GROUND STATION BUS

lays, the coal handling equipment having push buttons at various points for emergency shut down. Coal scale motors are controlled by three-way switches at the scales and at the distributing panel, and the economizer fan motors, of the slip ring type have drum controllers mounted on the boiler room floor for regulating the speed.

Station lights are supplied from a single transformer tapped off one phase of the leads of the power transformers, through three switches mounted on the main power panel feeding cut out cabinets, one in the boiler room, one in the basement and one in the turbine room near the bench board. Emergency light is provided by a double throw switch on the main power panel, which automatically throws several circuits in each cabinet to the exciter bus in case the a.c. lighting feed is killed. Later this emergency switch will throw to the storage battery to be installed for operating the remote control switches.

Turbine room lighting is from 200-w. units on the overhead trusses, with additional 100-watt lamps in ornamental side brackets, 17 ft. above the floor, Fig 9. Other lighting is by smaller lamps placed to give the best illumination. The boiler room has Welsbach multiple gas-arc units, to permit operation in case of an entire knockout on the electric equipment.

Three-way switches are provided for the bus and switch galleries to allow of turning lights on and off as a person goes from one gallery to the next, and flood lights on the roof provide for lighting the yard.

Bus Arrangement

ALL OIL SWITCHES, circuit breakers and field switches, and field rheostats are electrically controlled from the bench board and the adjoining vertical panels. Power for this control system is taken from 125-v., d.c. operating bus, which is supplied through a double-throw switch from either the exciter bus or the steam driven exciter. It is planned to install, later, a storage battery for operating this system in emergency, and the double throw-switch will then be changed so that, if voltage goes off the exciter bus, the switch will automatically throw the control system onto the battery.

On the first gallery will be the main 4000-v. bus, carried in a concrete structure so spaced that a 13,200-v. bus can be installed if necessary. This structure has five generator compartments, a station supply compartment, and three compartments that will later contain switches for connecting the main bus to the sections of the feeder bus on the second gallery. Ultimately, a continuous main bus will be installed to which all generators will be connected, but, at present, the three generators are connected directly to the feeder busses in the second gallery. Oil switches of medium capacity are now used in the second gallery, Fig. 14, but the structure is designed for using high capacity cell type switches as the load increases. Generator potential transformers are mounted in the bottom compartments of the structure, and current transformers on the main floor ceiling directly under the structure.

On the second gallery is the feeder bus, Fig. 14, divided into three sections, and consisting of a bar of copper 3 by ¼ in. for each phase, the insulators being arranged for additional bars of copper as load increases. The three sections are joined, but connection is taken from the first section for commercial power circuits, from the middle section for railway converter and from the third section for commercial and street lighting, as shown in Fig. 15, the general diagram of electrical connections. Power circuits are controlled by three-pole oil switches, while each of the lighting circuits has three single-pole oil switches, separately controlled, allowing single-phase service to be supplied with one phase out. An emergency bus at the top left of Fig. 16, can be used to serve any circuit while work is being done on its oil switch, the change over being made by means of double-throw

disconnecting switches. The outgoing cables are connected to the middle point of these switches and lead through current transformers up to lightning arresters in a pent house on the roof, seen at the back in Fig. 8, and the interior shown in Fig. 16. Some cables lead out to a rack on the roof, thence to pole line as seen at the back of Fig. 8, others lead down to the basement and connect to submarine cables feeding across the Fox River to supply load on the south side.

As there is considerable variation in length of circuits, it is necessary to choke down the voltage on the lines leading to the near-by business district and in the second gallery three hand operated induction regulators are installed for this purpose, the choking effect being adjusted according to the reduction necessary from the high voltage which has to be carried on the busses to

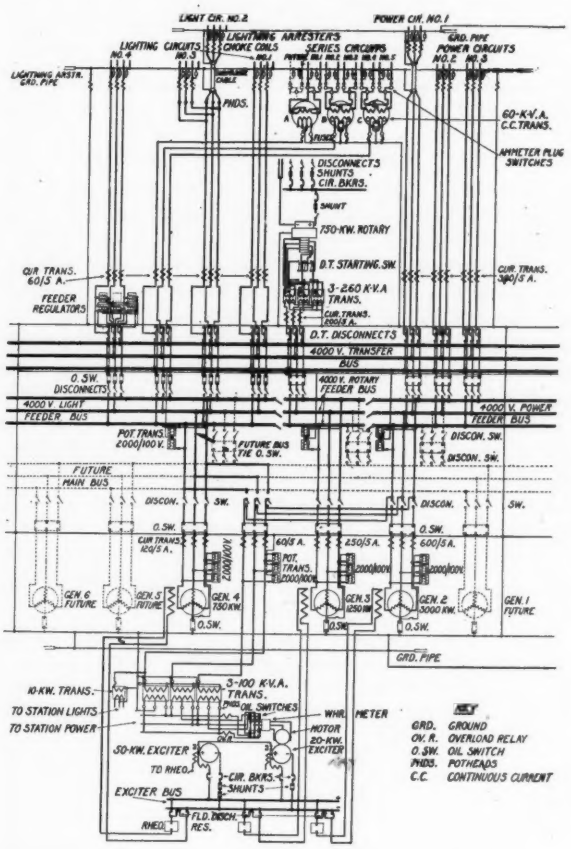


FIG. 15. DIAGRAM OF ELECTRICAL CONNECTIONS FOR THE SYSTEM

serve distant points satisfactorily during peak load periods. The present regulators were taken from the old plant but room is provided for future automatic circuit regulators, also for contact-making voltmeters on the switchboard.

Wherever possible, conduits are concealed in the concrete floors or behind the face brick on the walls and columns, those from control boards to galleries being carried up in the east wall of the building. All framing of machines and boards as well as instrument transformer secondaries are connected to the station ground.

Cutting Over to New Plant.

Before starting up the new station changes were made in the distribution system to fit it for the new connections and voltage, and the circuits were run into the new plant, alive up to the point of connection to the plant. The new generators were tested out at full load by a water rheostat in the river, and all apparatus was tested out for satisfactory working and insulation. All that was necessary, in cutting over the load, was to cut connections to the old plant, change over service transformer primaries from delta to star connection and connect to the new plant. This was done by sections and the entire work of shifting the load from the old plant to the new was accomplished over a period of 10 days, the shifts being made at times causing the least interruption to the service. The 500-kw. generator was then removed from the old plant, rewound for 700 kw. and 4000 v. and transferred to its new location.

General Operation.

Much care has been taken to provide means for controlling and keeping track of all operating conditions so as to secure the best possible economy, as well as to create a good appearance throughout the station and to secure pride in keeping it up. Every precaution is also observed to insure the safety of the system and the operating force, and much credit is due to Roy B. Meredith, local manager of the system and to E. F. Rider, chief engineer of the station, for the record maintained in efficiency and for the fine condition of the plant.

The entire design and construction of the station was carried through by the organization of William A. Baehr, consulting engineer, of Chicago, who has acted as consulting manager and engineer, to the property for the past 11 yr.

The British Government has begun an investigation into the water power resources of the United Kingdom to determine how far "white coal" may be relied upon to supplement the nation's coal resources. Through its English information service the Bankers Trust Company of New York is advised that special committees appointed by the British Board of Trade and the Privy Council are at work on the investigation.

Furthermore, an official Water Power Resources Committee has already examined and reported favorably upon nine separate schemes of water power development in the Scottish Highlands. These nine schemes, it is estimated, would yield an aggregate of 183,500 hp. at a cost much below the present cost of generating power in Scotland by the use of coal.

The Committee has recommended the appointment of Water Commissioners under control of the Board of Trade, to insure that British water resources shall be properly conserved and that all interested parties shall be treated fairly under future development schemes. It is proposed to divide England and Wales into water power districts, according to the conformation of water shed areas, under local committees whose duty shall be to secure the best development and use of the water power resources of the individual districts.

Life as we live it is the result of life as we view it.

Safety First

CLEVER MANIPULATION OF A LEAKY BLOW-OFF VALVE UPSETS BOSS AND DEMONSTRATES NEED FOR IMPROVEMENTS

"MANY'S the engineer who wears his brain threadbare watching and planning to make everything about the plant safe for his fellow workmen. They're capable, reliable men, who know their operating work fully, and are interested in the welfare of the business as a whole.

"Then again there's many a one, and maybe more than the other kind, who just keep the machinery going

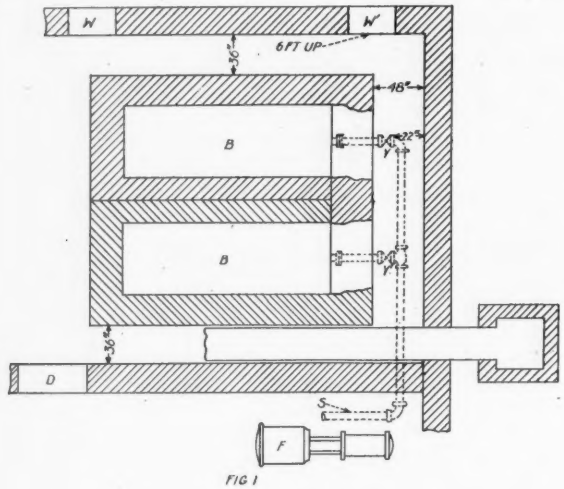


FIG 1

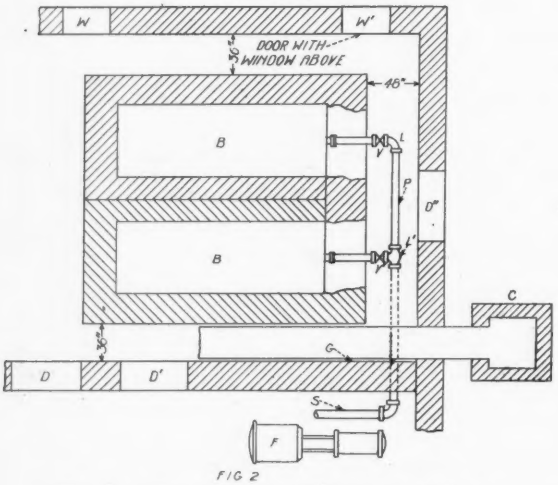


FIG 2

FIG. 1. THE PLANT AS TIMOTHY FOUND IT

FIG. 2. SHOWING DOORS WHICH WERE CUT TO GIVE LIGHT AND SAFETY

and let other things drag along until something happens. Then if it's a bad accident, they wake up and say, 'They can't blame me. The boss won't stand any expense for repairs or makin' things right!'

"And like as not they're telling the truth too; only maybe, if they'd wanted to a little harder they could have fixed up some inexpensive way to stop the accident, or could've found a way to convince the boss, same as my friend, Timothy, down at the cutlery works."

This was the contribution of Big Jim Leonard as we were discussing the new plans of the super for safety devices around the shop. It was the usual Saturday night gabfest in the smoking room at the club quarters for which all hands in the mills chipped in a quarter a week, and the "old man" paid the balance. Some day I'll tell you more about that club, but just now Big Jim's story is on the fire, as he told it to us that night.

"How did your friend Tim come it over the boss?" asked little Dan Fogarty, the fireman down at No. 2 mill.

Big Jim looked at him and smiled. "I said my friend Timothy. Nobody ever shortened that to Tim but once in Timothy's presence, and seldom out of it. Tim didn't fit him, but Timothy did. He was tall, lank, solemn, taciturn; never talked when he could help it; and when he must speak used as few words as possible, but frequently in unusual ways. Funny, with his mania for breath saving, that he wouldn't have Tim. But he just wouldn't, and if a new acquaintance tried it on, Timothy rose, answered, if an answer was needed, in precise and elaborate English, and stalked away without looking at the offender."

"Well, then," said Dan, "if he was so partiklar, how'd Tim-o-thee put it across, seein' he evidently didn't do it by out-talkin' 'im?"

"It's some story, but I guess we got time," returned Jim. "Anybody got some chalk? This novel is to be hand illustrated."

After searching of boxes of odds and ends, a stick of crayon was unearthed and passed to Jim by Charley Geneau with the remark, "Ere's your crayonne. Plees make your peecture elegant and clear. I can understand her, but your talk is sometimes most rapid."

"All right, Charley Gene," said Jim; "I'll draw it big and plain, and you listen sharp. You'll get half of it, and the other half you can guess. Let's go."

The bunch pulled up chairs in front of the blackboard and sprawled into comfortable positions to hear the story.

"As I said," began Jim, "Timothy was a man who believed in action rather than talk. He argued by object lessons which were hard to talk back at, and he made his point. But he did a lot of thinking before he started anything.

"The plant was a small one, and the owners had a reputation, rightly earned, of being the tightest fisted people in the state. They had more than twenty engineers during 2 yr., who came, got enough, and quit. So Timothy didn't expect to find the plant in apple-pie order, and he wasn't disappointed. But he was the kind that likes to tackle a hard problem and work out the answer. Also he had been knocking around on construction work for a big firm, and he got the idea that staying home for a while and playing around in a small plant would be a change and a rest. Anyway he could get three meals a day of his wife's cooking instead of boarding-house leftovers and way-station lunches, such as the installing man, whose hours and travels are irregular, has to put up with.

"Well, Timothy, who was number 22, hung up his hat and began to look around. He had one piece of baggage that he always carried; a long, lank black pipe that fitted him exactly. He was always chewing on it, and when he was hunting trouble, he would puff at it fast and hard, but usually forgot to light it, so you heard the puff, but didn't see any smoke. When you talked to Timothy, he took out the pipe, pointed the long black stem at you and listened, looking straight at you. When you were through, he puffed at the dudeen, looked at the ceiling, and after a while replied, but not often more than a dozen words.

"I didn't see Timothy for three or four weeks, and I was wondering how he was getting on, so one day I dropped in on him and was astonished to find him having a friendly talk with his boss in his usual fashion. That is the boss was talking at the end of Timothy's long black pipe stem and Timothy was listening, then leaning back, looking up and stating his decisions.

"I wanted to find out how it happened, so waited until the boss had gone, and by many questions finally got at the how of it."

Here Jim turned to the blackboard and drew a plan as he talked. "These two 100-hp. boilers, B and B, were set in battery with blowoff pipes running down into the ground so as to discharge through the pipe S into the sewer in the sub-cellar. Valves V and V' were set horizontal with the stems upward and were well away from the boilers so that there was only 22 in. from the valve wheel to the wall. There was some light from window W', but as the sill was 6 ft. from the floor, the space behind the boiler was pretty dark; but the boss couldn't see any need of light in there, for as he said, 'Nobody ever went in there except a minute or so to turn those valves, and you could do that by feeling.' Timothy had seen things happen at the back end of a boiler before and he wanted more light, also some way to get out quick in case of an accident. But he waited for a chance to prove his point.

"There was another thing Timothy didn't like. The feed pump was at F, and the fireman couldn't see it unless he went out through the door D into the pump room. As the boilers were worked hard, the fireman was kept right busy, and sometimes forgot to look after the pump, which was also worked hard and needed attention to keep it moving right. But again the boss said, 'All the fireman has to do is shovel in the coal and keep that pump going, and he can step out there just as easy as not.'

"The boss had the habit of rushing out anywhere in the plant where the engineer was working, to argue about the expense of the power plant and how it was costing too much. One day, Timothy was in back of the boilers packing the valve stems and had the packing nearly all out of the valve V', when in rushed the boss all set for his usual harangue. He came over close to Timothy and started in, but Timothy kept on trying to get the last ring of packing out and said nothing. The boss looked at the packing which was out and said, 'Why do you take this out? It looks all right. No need to throw this away and put in new packing. Packing costs a lot of money. You shouldn't change it while it's doing all right.'

"Timothy grunted, straightened up and said, 'Leaks steam; want to see?' and stepped over to valve V, which he partly opened. The rush of pressure loosened the last ring in the stuffing box and—whoosh!—a stream of steam and water shot up past the valve stem, filling the space behind the boilers and moistening the boss profusely. He uttered one word, which sounded like Helen M. Nation and started to leave—rapidly. The steam befuddled him and he hit valve V', went into reverse and hit valve V, which Timothy had quickly closed, slipped and landed full length with glasses broken, and shins, elbows and temper the worse for the encounter.

"Timothy picked him up, carried him outside, brushed him off and then said, 'You see she was leaking, and we'd like a little more light there, some air and a way to get out quick.' 'Five dollars for my glasses and nearly broke my neck,' the boss fumed. 'Say, fix that place, and any more like it quick's you can. Feller's likely to get killed in such a hole.' And the boss stalked away.

"Changes were started at once. Timothy had a sliding door put in at D" and window W' cut down to the floor with a glass panel door and transom, also a door at D' so that the fireman could see the pump. The other doors gave light and air, also a place to take ashes out of the back end. 'And,' said Timothy, 'The boss is right liberal minded when you once show him.'

"As a matter of fact, when I went in the boss had been telling of something that he thought ought to be done, and Timothy had said, 'Mm no, I'll look around and fix it.' And as the boss left he had said, 'Well, Timothy, I'll leave it up to you.'"

Envy

By J. W. Shaw

CAST not jealous eyes upon
The man who wins success.
You'll never rise into his realm
If you just work by guess.

Envy not his masterful
Dispatching of his work.
For chance is yours to master
All the duties you now shirk.

Covet not his tools or methods
Nor the way he handles men.
All these things are yours if you'll
Just study now and then.

You'll find it hard to climb the rungs
That lead to wealth and fame,
But meet your failures with a smile
For it's all in the game.

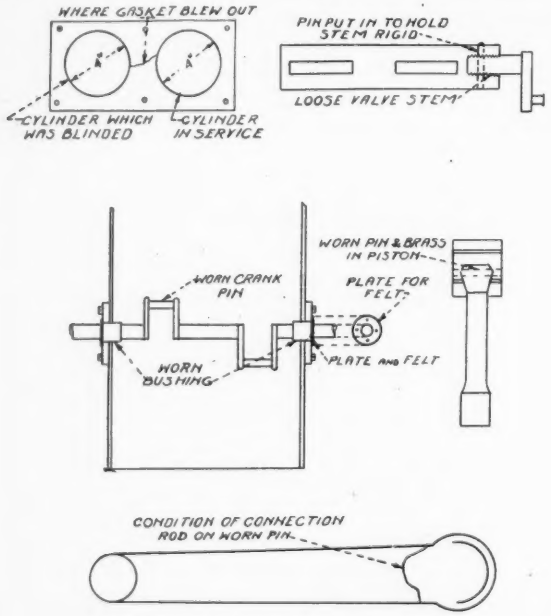
Dream your dreams, but watch your chance
And always forge ahead.
Be not content to sit and wait;
Get up and do instead.

And then some day, if you've been true
To self as well as study,
You can lay a claim to fame
And call success your "buddy."

Kept the Stoker in Operation

THE STOKER ENGINE on a 300-hp. boiler equipped with a side feed furnace, started to give trouble by pounding and running at a fluctuating speed. The operating engineer tried adjusting the eccentric rod, thinking the valve was not cutting off properly, but by doing this, the engine stopped and he could not get it to start again.

The valve was taken out, but things seemed to be all right at this point except for a little lost motion at the head of the eccentric rod. This was taken out and the valve replaced and set. In trying to start the engine, it would give a half turn and stop with a jerk as if the piston was striking the head or there was water in the cylinder. The cover on the crank case was taken off


WHERE GASKET BLEW OUT
PIN PUT IN TO HOLD STEM RIGID
LOOSE VALVE STEM
CYLINDER WHICH WAS BLINDED
CYLINDER IN SERVICE
WORN PIN & BRASS IN PISTON
WORN CRANK PIN
PLATE FOR FELT
PLATE AND FELT
WORN BUSHING
CONDITION OF CONNECTION ROD ON WORN PIN

CONDITION OF STOKER ENGINE PARTS

and it was found that the crankpin had worn up through the brass and up into the connecting rod 1½ in., on the left-hand side; the crankpin was badly cut and scored. The brass and pin on the right-hand side were worn, but it could have been run longer; this had to be removed on account of the brass and pin in the piston being worn beyond repair.

When making this repair, it was found that there was only one rod and set of brasses on hand. In order to keep the stoker in operation, it required blinding off the cylinder on the left-hand side by putting on two pieces of 1/32 rubber packing and one piece of tin placed between the rubber packing.

The engine was run on the one cylinder for five weeks. It did not run quite so smoothly as it would with the two cylinders, but it did what was required of it.

On making the final repair, it was necessary to put in a new crank shaft, one connecting rod, crank end brasses and pins and brasses on piston end. When filling the crank case with oil, it was discovered that the oil was running out around the crank shaft where it passes through the casing. As there were no new brass bushings to replace the worn ones, it was necessary to make two plates and put pieces of felt in between the plates and the casing.

When the engine was started, it ran very smoothly for about an hour, when it stopped. It was discovered that the valve stem thread had stripped and would not operate the valve. After drilling through the valve and stem and putting in a taper pin, the valve worked all right. The operating force on the 11 p.m. to 7 a.m. watch reported the following morning that the gasket had blown between the two cylinders, which caused the engine to stop. Since this trouble was remedied, the engine has been running very smoothly.

The accompanying sketch will show more clearly where the defects were. C. J. MILLER.

To be Sure that Ammonia Drum is Empty

IT IS usually considered quite a trick to charge an ammonia plant with anhydrous ammonia and get all of the anhydrous out of the ammonia drum.

Very often the erecting man thinks he has gotten all of the anhydrous out of the drum and sends it back to the ammonia manufacturer with only a portion of the anhydrous removed. The writer knows of instances

FIG. 1. POSITION ASSUMED BY DRUM CONTAINING SOME LIQUID

FIG. 2. EMPTY DRUM IS READILY BALANCED

where 100-lb. drums have been sent to jobs containings 100 lb. of anhydrous ammonia and possibly the whole 100 lb. was returned by mistake because the erecting man thought that he had fully charged the plant.

The erecting man could easily have tested the drum before and after to determine whether or not it still contained liquid, but he evidently did not know the very simple method illustrated herewith.

Figure 1 shows the drum containing some liquid. Try to balance the drum on a block of wood as indicated

and you will find it practically impossible to do this because the liquid will run to one end or the other. Also, by listening carefully, one can hear the ammonia as it strikes the lower end.

When the ammonia is all removed, it is a simple matter to balance the drum on the same block of wood as indicated in Fig. 2.

This is an infallible test which is valuable because of its simplicity and because of the fact that it is not necessary to weigh the drum at any time.

F. W. SCHAPHORST.

Dry Valves

THE IMPORTANCE of the proper amount of cylinder oil in drop cutoff engines is an important factor. As shown by the cards herewith, the lack of it being the cause of a certain factory being shut down for 1½ days.

This engine had gridiron valves and began to act strangely; the back pressure gage showed 10 lb. and steam began to drop. The engineer, thinking the cams had slipped, attempted to adjust them, and Fig. 1 is the result of his efforts.

Three able chiefs of neighboring plants were sent for, all having larger plants than my own at that time; but they threw up their hands and refused to touch the engine.

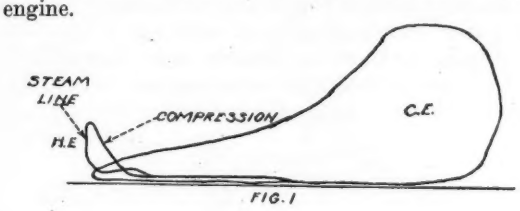


FIG. 1

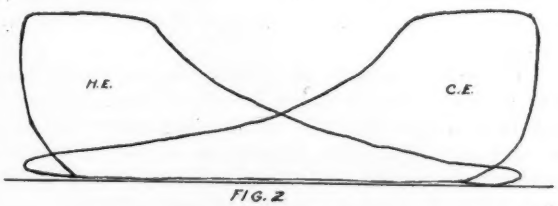


FIG. 2

FIG. 1. CARD TAKEN BEFORE ADJUSTING
FIG. 2. CARD TAKEN AFTER ADJUSTING

Arriving at the plant about midnight, after a wild 7-mi. ride in the super's auto, I found seven men there, from first class engineers down, waiting to see the show. I didn't like that part of it, so I told the super if he wanted this mixup straightened out, he would have to clear out the engine-room of rubbernecks, or I could not work, which he readily did.

Applying the indicator, I got No. 1 for a starter, which shows that everything had been put back until the engine lay down, the original cause of which was dry valves, refusing to drop. Number 2 is the last card and resulted in enabling 160 people to go to work the next day.

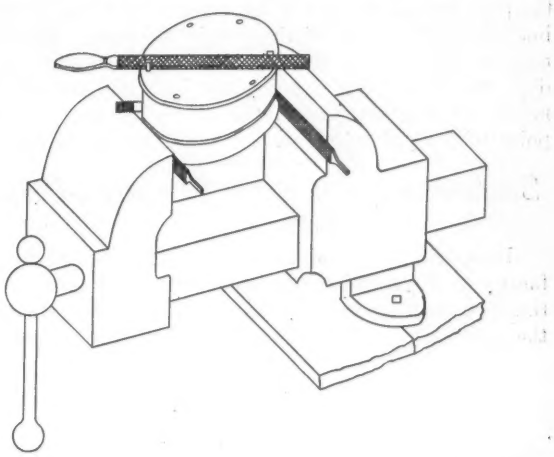
In another instance, I happened into a friend's plant one Monday morning just at starting time. He said to me, "Hold onto the throttle, Doc, while I attend to the fire, as she is racing badly."

Sure enough, he told the truth, as it had already blown all the fuses on the motors. I at once surmised the cause of the racing. Looking down, I saw that the valves were not dropping and as it was Monday morning, I knew that they were liable to be dry. There was a force feed oil hand pump attached, so I forced in some cylinder oil with it. Bill opened his eyes and remarked, "I have never used it since I've been here." Thus ended his troubles; the valves dropped o. k.

A. C. WALDRON.

Removing Rusty or Corroded Glass Rings of Steam Gages

THE DIAL glass rings of steam gages frequently rust and corrode on so that they cannot be removed at all with the hands alone. If one tries to grip them with wrenches, pliers or other tools in a hurry, the rings are easily defaced and bent. The sketch shows how to grip



METHOD OF REMOVING GLASS RINGS OF STEAM GAGES

them in the vise quite safely, by means of two files. The vise should be tightened only enough to grip the brass lightly, but it is surprising how securely the files will hold the ring without in the least bending or defacing it, with the exception, perhaps, of a few light scratches on the outside of the narrow rim which can quickly be removed.

Leverage is secured by means of another file or strip of iron dropped between two small bolts slipped into the bracket holes in the back of the case. If the body can be moved only the least extent, the gage can, in the majority of cases, be removed and the ring then turned off with the hand; but to get it started is where the difficulty lies. The writer has removed a great many rings in this manner and has never spoiled or had an accident with a single one, and some of them were apparently there to stay on.

F. W. BENTLEY, JR.

Records

RECORDING gages are one of the most important factors in the power plant operation. They are the only means by which the operation of the plant may be kept on file.

What good are these records if the chart is not set at the right time? If unusual variation in temperature

should occur at 1:35 a.m., and the chart which is 10 min. slow, will record it at 1:25 a.m., how is that record going to stand if the chart is compared with a record taken on another branch of the system on which the variation occurred?

If charts are changed at 12:00 midnight, let them be changed at that time, and if, by any delay, the change should be 15 min. later, the chart should be set at the time of the change.

The clock is the heart of the record and on the running of this apparatus depends the recording of the steam, air, water, or anything else. It should be wound at the time specified by the makers.

Upon glancing at some records, the thickness of line is noticed. Sometimes the line is ¼ in. thick. Such records are as good as useless because the line thickness hides the true record.

The causes of thick lines are, first, too much ink in the pen; second, the pen is incrusted with dirty or dried ink; third, the point of the pen is too wide. The first may be remedied by putting one drop in the pen each day; the second, by scraping the ink from the pen by means of fine sandpaper; the third, by pinching the point with a pair of pliers. CLEMENT COREY.

Single-Acting Pump that Discharges During Both Strokes

INQUIRIES are received almost daily by the manufacturers of a certain pump asking how it is possible for their cylinder pump to pump both strokes. Many of the writers go so far as to claim that it is impossible.

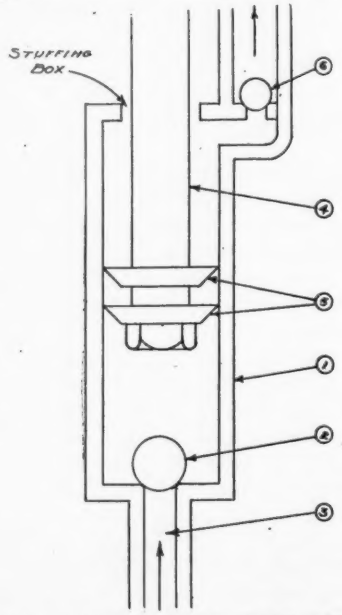


DIAGRAM OF SINGLE-ACTING PUMP WITH DOUBLE-ACTING EFFECT

To explain the principle in as simple a way as possible, I am furnishing a sketch here with parts numbered. The working principle is as follows: (1) is a cylinder filled with water, (2) is a steel ball in a seat which prevents the water from returning back into the suction pipe (3) through which it was originally pumped by plunger (4). Since all of the space in the cylinder beneath plunger and around it is filled with water, it is evident that on the upstroke of the cups (5), this upstroke will cause the up-flowing water to lift steel ball (6) and water will be forced upward through the outlet pipe in the direction of the arrow.

Next comes the down stroke. Cylinder (1) is full of water. The plunger (4) occupies considerable space. Inasmuch as it is impossible for two bodies to occupy the same space at the same time, it is clear that water will have to be displaced by the plunger as it moves downward. Ball (6) will be raised and oil will again flow upward.

Thus it is evident that this pump discharges on both strokes, a feature that is desirable for maintaining as constant a flow as possible with consequent saving of energy, impact stresses on the working part, and sand isn't given an opportunity to settle. A double-acting pump is always more desirable than single-acting pump —a triplex pump more desirable than a double-acting pump and so on up until we reach the centrifugal pump which maintains a steady stream, free from fluctuations.

I wish to explain that the actual pump manufactured by this company is not at all like the sketch shown. This sketch is drawn merely to clarify the working principle—make it simple and understandable. The actual pump contains four steel balls and it also contains springs, packings and leather cups; however, the extra balls are only used to insure against leakage and do not in any way change the operating principle.

N. G. NEAR.

Economical Heating with Steam Coils

IN HEATING liquids and rooms by steam in steam coils or drums, the average engineer is not careful that all the steam in the coils is condensed before it is allowed to escape.

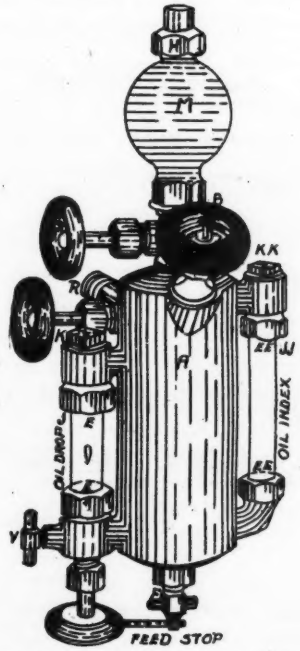
The chief engineer, upon entering the power plant one morning, noticed that a volume of steam was escaping from a steam coil that was heating heavy fuel oil in a concrete tank. The assumption of the engineer in charge was that the oil could be heated much quicker and hotter by letting a certain amount of steam escape with the condensates from the discharge valve. This assumption, of course, was just the exact reverse from what the engineer wanted or thought.

For example, take this heating coil and let steam enter it with the exhaust valve wide open. With this valve wide open, the pressure inside the steam coil will be very near atmospheric pressure unless the steam inlet is larger than the outlet. If the steam inside the coil is at atmospheric pressure, then the temperature of the steam will be near 212 deg. F., and the transfer of heat from the steam coil to the oil will depend on the difference in temperature of the steam in the coil and the temperature of the oil; hence the transfer of heat is slow. Besides this low transfer of heat from the coils to the oil, the loss of heat that is carried away by the escaping steam is to be considered a great deal more than the transfer of heat. The latent heat of steam at atmospheric pressure is about 970 B.t.u. of heat per pound of steam. If this steam is condensed before it is allowed to escape as condensates, it will give up to the oil the 970 B.t.u. of heat.

Now, consider the condition when the discharge valve is closed to the escaping steam, and only the condensates are allowed to escape; the steam pressure in the coils becomes the same pressure as the boiler pressure. In this case, the boiler pressure was 150 lb. gage pressure. Steam temperature at this pressure, according to steam tables, is 365 deg. F. Then the transfer of heat will be much greater between the coils of 365 deg. F. and the oil. It is true that the condensates escaping at 150 lb. gage pressure will contain more heat units than condensates escaping at atmospheric pressure; but if oil is to be heated quickly, then it is necessary to heat it under higher pressure; the lower the pressure that can be carried on the heating coils, however, the greater will be the efficiency of the heating coils. If the condensates are carried back to the boiler, there will be no heat loss in the escaping condensates. W. A. DARTER.

Lubrication Adjustment

ONE OF the great sources of loss in the engine room is through the sight-feed lubricator used on steam engines, pumps, etc. In many plants, the lubricators are



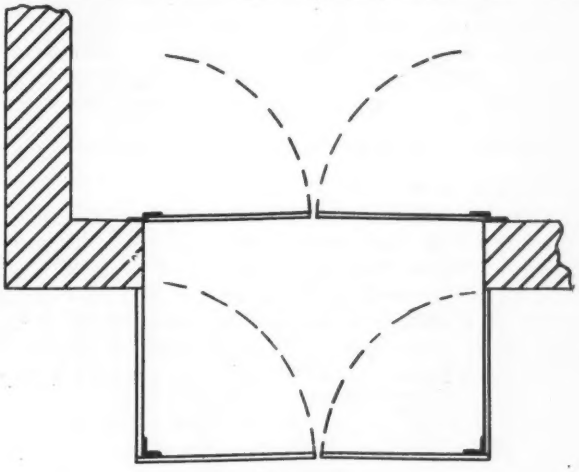
METHOD OF APPLYING FEED STOPS

set so the drop will rise at regular intervals without any reason for that particular regulation. Too many engineers give the matter of lubrication little thought, while it is an engineering subject of great importance. The engineer should make a study of and become acquainted with oils and particular places to be lubricated.

After these things have been done, next is the care in feeding, where the oil is used in cylinders. We have nearly all noticed a notch cut or filed in a certain place on the wheel or handle of the feed-valve, and this notch is supposed to be set in line with some part of the engine room or the machinery, to have the lubricator run enough drops per minute to prevent a squeak or groan in the cylinder. The more certain way is, after correct regulation is found, to drill a small hole in the feed-valve wheel or handle just large enough to admit a piece of telephone wire to be admitted tightly at a point directly in line with drain valve F, so the piece of wire shown will bump against F when the feed-valve is open. With this regulating stop, the feed cannot be opened too far and if more or less feed is desired, the wire can be bent slightly so as to make the change. GEO. W. STITT.

Double Doors for Winter

IN MANY of the smaller power plants, it is necessary to hand-wheel coal and ashes into and from the boiler or engine room and during the cold winter months the engine room is frequently made uncomfortable by the blast of cold air which rushes in while the doors are opened to permit passage of the barrows. In one plant with which the writer was connected, we prevented this



SWINGING DOUBLE DOORS FOR BOILER ROOM

inconvenience and cause of frequent colds, by putting up a double winter door as shown in the sketch. Swinging doors were used, so arranged that the one set of doors would close before the others were fully opened. This arrangement, which was put up at a cost of about $40, proved to be a good investment in cutting down drafts and chills in the power house. M. A. SALLER.

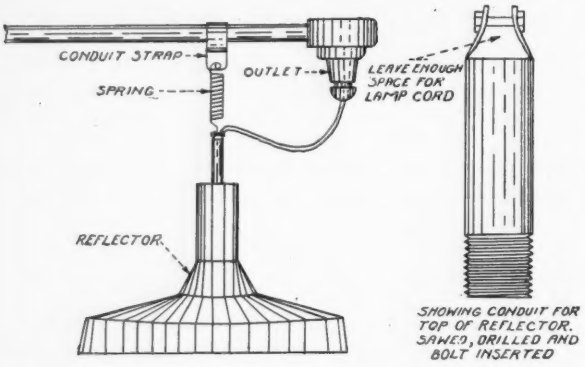
City License a Failure

I HAVE recently discovered by personal experience another reason why the State of New York should have a license for steam and operating engineers.

Shortly before coming to Rochester, I was in a city that was non-licensed. I left there to take a place in a small village that was licensed. I had no trouble at all in securing the license. Later I came here and have so far been unable to obtain a license. The applicant must state on his application the name, size in horsepower and owner or employer, and have two people swear to it. You must have a license here to get a position and you must have a position in order to get a license. Out-of-town licenses are not even recognized. This city has over 250,000 inhabitants, a first-class city. I know two plants where the engineers are running on licenses dead for nearly a year. With a state license all this foolishness and nonsense would be put down and a man with a state license could find employment anywhere. S. G. RAY.

Increasing the Life of Lamps

WE FOUND after installing a lighting system in a tank room where monorail hoists are used, that the vibration of the hoists caused excessive breakage of incandescent lamp filaments. After changing the supports for the lamp fixtures, it was found that the life of the lamps was increased several hundred times.



METHOD OF HANGING LAMP TO PREVENT BREAKAGE OF FILAMENT

The fixtures as originally installed were fastened directly to the steel work of the building in the usual manner. These were taken down and hung on short coil springs made out of No. 16 B. & S. gage steel spring wire. The manner of hanging is shown clearly in the illustration. Care should be taken that the spring be weak enough to allow the fixture to have a good springing motion when tried with the hand.

V. A. BLOXHAM.

Stop! Look! Think!

A GREAT many, no doubt, know of the head-on collision between two interurban electric cars near the city of Denver, Colo., on Labor Day, the first wreck in the history of the Kite Railway, and as usual in most cases, due to carelessness in investigating the causes, etc., William C. Reid, special investigator of the Colorado state public utilities commission, says: "There is a big cottonwood tree located in such a position at the curve that had it been removed, there would have been a vision of 500 ft. more than was possible with the tree in position and if this tree had not obscured the motorman's vision, they would have seen the impending disaster and would have been able to stop their cars fully 25 ft. apart—even at the speed they were supposed to have been going—making the collision impossible."

Right here arises the question: Why is it that this tree was allowed to stand?

Is it always to be that some terrible accident must happen ere precautions are taken?

Now, bringing the matter nearer home, are there not in many power plants some obstruction, unprotected gears, careless ladder work, etc., that somebody is going to fix, or rectify "tomorrow"?

Why procrastinate? Surely anything that looks dubious, suggesting a chance for an accident, is dangerous and should be corrected instantly.

Too busy, you say.

If we are too busy to correct and remove faults when we see them, why is it that we are not too busy to give first aid when accidents occur?

Remember the old saying: "An ounce of prevention is worth a pound of cure." Study conditions daily and like the fictionist who builds up his story generally through imagination, think of what would happen should such a thing be left unfinished, or unsecured.

If that is done and it must be, for "eternal vigilance is the price of safety," we will not permit menaces in our midst. Possibly because of its beauty, the tree was overlooked in so far as its bad features were concerned; for "pretty is as pretty does," and surely had anyone made the proper inspection, this tree would have been removed many days earlier.

The rules of Safety First were ignored and whenever that is done, there is but one way to explain it and that is to say that carelessness predominates and danger hovers.

J. B. DILLON.

Rebuilding an Automatic Pump Governor

IN THE plant where I am employed, we have a tank and pump for returning the heating system condensate back to the boilers. Figure 1 shows the original layout.

The cast-iron bucket was open at the top and almost

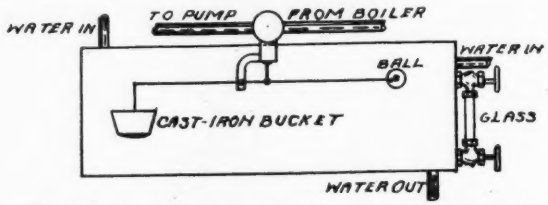


FIG. 1. ORIGINAL PIPE CONNECTIONS FOR RETURN WATER TANK

directly under an opening where it was always getting filled, so it naturally kept the valve open. I took out all the inside mechanism of this tank and rigged it as shown in Fig. 2.

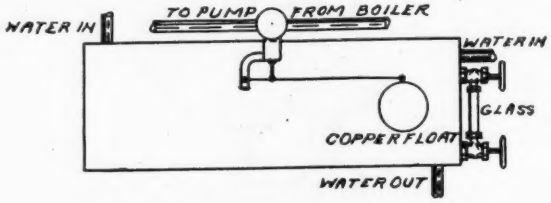


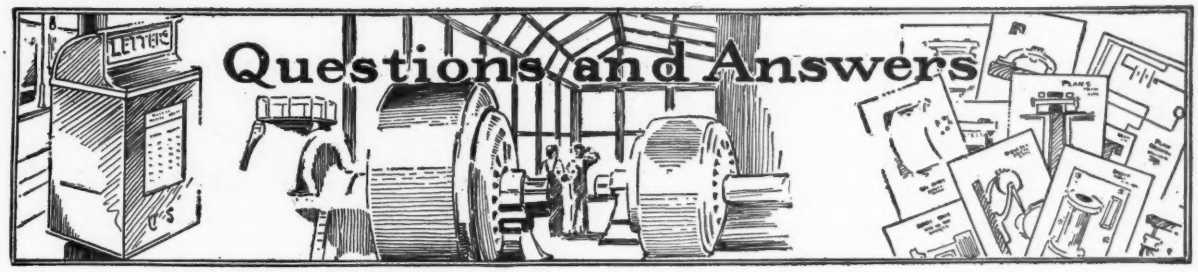
FIG. 2. TANK FIXED WITH FLOAT VALVE

I removed the lever bucket and ball on the stem of the governor valve and instead placed a lever and large copper float as shown. This is very positive and the governor works very well.

R. G. SUMMERS.

GOVERNMENT has taken notice of the effectiveness of engineers and has appointed Willis B. Richards & Co., of New York, to investigate the efficiency of the U. S. Mail Service. This will cover methods of securing employes, the various ways of handling mail in and between stations, arrangement of buildings and all other matters affecting the economy and efficiency of the department.

"TO CORRECT in ourselves what we would condemn in others would remove most of the evils of life."



A Four-Valve Engine Diagram

I WOULD APPRECIATE having the opinion of your readers on this indicator diagram taken from a Chuse four-valve engine; bore, 19 in. by 24 in. stroke, 195 r.p.m.; steam pressure, 105 lb. gage. D. R. B.

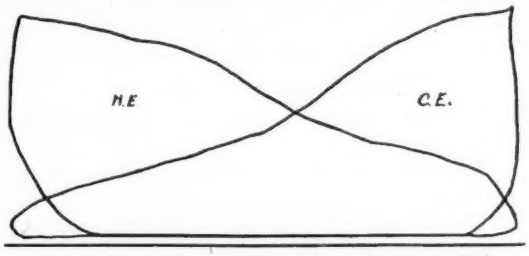


DIAGRAM FROM A CHUSE FOUR-VALVE ENGINE

Oil Engine Operation

IN THE Oct. 1 issue A. D. asks for information concerning his De La Vergne oil engines. He does not say whether he is having any trouble or not, nor does he state the type of engine; but I am assuming that they are D. H. type.

The main thing he wants to watch is his water jackets in the cylinder head, especially if there is any scale forming matter in his cooling water. Then if he keeps his fuel pumps, spray valves and bypass valve on the governor in shape, he should not have any trouble.

I have run a twin cylinder, 120-hp., D. H. type De La Vergne engine 42 days without a shut-down and 40 days at another time without a stop and have made several 15 to 30-day runs.

In regard to the governor trouble described on page 1096 of Nov. 15 issue, I believe that the trouble is caused from the valve and seats being a little rough from the planing. If the springs on the governor arms are given more tension and weights added to the governor arms to get the proper speed of the engine, it will give better results. JESS C. MOSER.

Governor Trouble; Unaflow Engine Diagram

IN ANSWER to a question about governor trouble which appeared in the Nov. 15 issue, I would say that if you have tried shifting the cutoff and do not get satisfactory results, it is likely that the bearings and pivots do not work freely, caused probably by poor lubrication. The parts of a governor must function freely in order to respond to slight changes in speed of the engine.

The Buckeye governor is provided with an auxiliary spring that acts in opposition to the main spring through the first half of its outer range. At this point, the auxiliary spring should cease to operate. If this spring is stiff, it would have a tendency to hold the weight out which would prevent its shifting when the speed changed a small amount. This would cause the engine to hunt.

Good lubrication of your governor bearings and pivots will probably effect a change for the better.

In regard to the indicator card taken from an Ames Unaflow engine, on which G. C. H. wants criticism, for the speed at which this engine is running, 247 r.p.m., the card is good. The admission is a little early as shown by the backward slant of the admission line. It should be perpendicular to the atmospheric line. With the kind of valves that this engine has all the other points, cutoff, release and compression are also early. To remedy this: Shift the eccentric to decrease the angle of advance. The wavy lines are always noticeable on high-speed cards and are due to inertia of the indicator. About two years ago, I got some cards from a 16 by 16-in., 257-r.p.m. Ames Unaflow engine using steam at 150 lb. pressure that looked very similar to those presented by G. C. H. By decreasing the angle of advance, we obtained a marked improvement. LESLIE KLOCK.

Refrigeration Kinks

WE HAVE four sharp freezers, for freezing fish—salmon, halibut and cod. Each freezer holds from 20,000 to 25,000 lb. of fish. The temperature averages about 18 to 20 deg. F. after the freezers are filled. We are expected to pull them down to 15 to 20 deg. below zero in from 16 to 20 hr. Is it possible to have too much machine on the job, that is, evaporate the ammonia too fast, to get best results? What is considered the best way to handle a battery of sharp freezers that are filled each afternoon from one to two hours apart? We have plenty of compressor capacity. 2. When the expansion valves on the sharp freezers are all set about alike, does the liquid ammonia have a tendency to run to the coldest coils, or do these coils fill up first because of the slower evaporation due to their being colder?

3. In blowing the oil from the bottom of liquid receiver into regenerator, does it make any difference whether valve on receiver is opened just a little, or opened wide? One of the operators here claims that valve should be just cracked, otherwise the liquid ammonia will force its way ahead of the oil into the regenerator, leaving most of the oil behind in receiver.

4. Is there any danger in turning cold water through compressor water jacket suddenly after the cylinder becomes hot?

5. We have had a good deal of trouble during cold spells throughout the winter months with drop pipes, through which the air for agitating the water in the ice

cans passes freezing up with the resulting white ice. This I believe is due to the moisture in the air condensing while passing through the cold pipes and then freezing. How is this air best dehydrated so as to prevent this freezing up during cold spells? E. E.

ANSWERS

YOU CANNOT evaporate ammonia too fast to get results.

It is rather difficult to give any set rules for handling a battery of sharp freezers, without knowing the layout of the plant, size of freezers, number of feet of pipe and size of compressor, temperature of product when placed in freezer, etc.

The general procedure in most plants is to start running on the rooms about 2 hr. before they are filled.

2. The coldest coils will have a tendency to fill with liquid ammonia, due to the slower evaporation of the ammonia in them, hence less resistance against incoming liquid from the feed or expansion valves.

3. In blowing oil from the bottom of the liquid receiver to the regenerator, open the valve wide and blow down about 1 to 2 in. of liquid at a time.

4. There is danger in turning cold water through compressor jacket suddenly when the cylinder is hot. Just as much danger here as it is in turning cold water on any piece of casting that is hot. You might crack it.

5. Frozen drop pipes in ice cans are a common occurrence when the outside temperature drops considerably. The remedy for this is to have the temperature of the air going to the suction of the blower or air compressor, as the case may be, not lower than 75 deg. F.

This temperature can be obtained by having the air to suction of blowers pass over steam coils, or through radiators, increasing its temperature to the required amount.

This temperature will eliminate the moisture in the air and stop freezing up of the drop pipes.

C. E. ANDERSON.

Additional Condenser Surface

I AM operating a 20-ton Vilter ice machine for refrigerating duty, direct expansion system, cooling water is 59 deg. F., there are three storage rooms in which butter is stored and which are kept at a temperature of 35 deg. F., and 2400 gal. of water to be cooled per hour from 59 deg. F. to 42 deg. F. This water should be cooled down to 36 deg. F., as it is used for a pastureizer in a creamery. The suction pressure is 35 lb. and condenser pressure is 200 lb., which I think is too high. There are 400 ft. of 1¼-in. pipe in our double-pipe condenser. Would adding another stand of 200 ft. of 1¼-in. pipe to the condenser help reduce the condenser pressure? Would it help in cooling the water down to 36 deg. F.? B. D.

A. Adding another stand of condenser will help greatly to reduce your head pressure. Your present condenser should be purged as no doubt it contains non-condensible gases, which are causing a good deal of the high condenser pressure. After installing an additional 200 ft. of double-pipe condenser, you will find that you can increase the opening of your expansion valves without raising the suction pressure, consequently evaporating more ammonia per minute than before. Increasing the amount of ammonia evaporated per minute increases the tonnage.

No doubt after this change is made you will have no difficulty in cooling the water from 59 deg. F. to 36 deg. F. C. E. ANDERSON.

Low Pressure for Soot Blowers

CAN I USE a soot blower to clean 4-in. flues, 18 ft. long with 30 lb. pressure? SUBSCRIBER.

A. It is not practical to use mechanical soot blowers with pressure under 50 lb. and then for tubes not over 18 ft. long. At pressure lower than this, the force of the steam is not sufficient to do the work; also, the steam is likely to carry considerable moisture. It is better to have at least 75 lb. pressure when using soot blowers.

Sensitiveness of Governor

HOW DO YOU figure the height of a pendulum governor, revolving 90 r.p.m.?

2. How does the height of the governor affect its sensitiveness?

3. If the height of a simple pendulum governor is 8 in., what is the equivalent height if a weight equal to 1½ times the weight of the balls is added? E. M.

ANSWERS

REPLYING to your questions in regard to the pendulum governor, the formula for this is that the height in inches is equal to 9.775 divided by T squared, where T

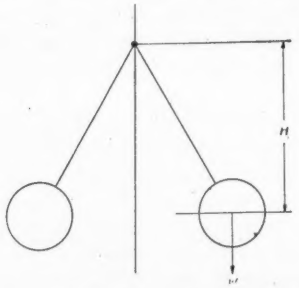


DIAGRAM SHOWING HOW HEIGHT IS MEASURED ON A PENDULUM GOVERNOR

is the revolutions per second; 90 r.p.m. would be 1½ revolutions every second, which would give for the height 4.345 in. measure, as shown on the sketch herewith.

As sensitiveness increases with height, the greater the height of a pendulum governor, the more sensitive it will be. For a weighted governor, the equation for the equivalent height is as follows:

$$H'' = \left(\frac{187.7}{N}\right)^2 \frac{B + 2W}{B}$$

Where H is the height in inches, N the revolutions per minute, B the weight of the two governor balls and W the weight of the counterweight.

In the case of your question, it is assumed that the speed of the governor will be the same before and after the counterweight is added. In that case the height would vary according to the last member in the equation. When there was no counterweight, the value W would be zero, and the value of this last member would be 1. When

W is equal to 1½ B, the expression becomes B plus 3B, divided by B, which equals 4, so that if in the first case the height of the pendulum had been 8 in. the equivalent height of the weighted pendulum would be 4 × that or 32 in.

Feed-Water Heater

WE ARE DESIROUS of making a change in our feed-water system with a view to economy. We now have a pump and an injector delivering water to our boiler. The feed water flows from the tank by gravity to the pump at about 50 to 60 deg., through the pump to a closed feed-water heater to the boiler at an average temperature of 180 deg. We also have a hot-water tank to which the condensate is returned. Water from this tank at about 140 deg. is used for washing. Our only water supply is from the city mains at about 60 lb. pressure.

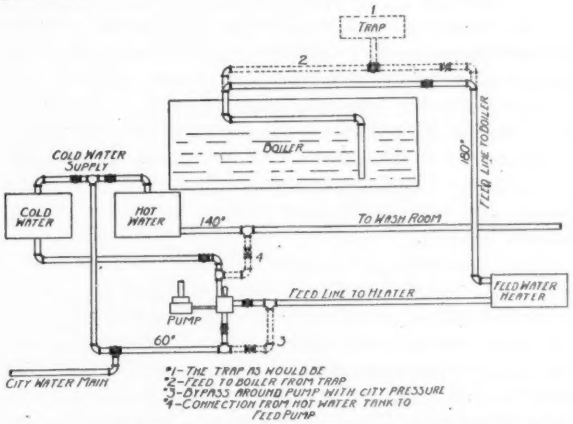


DIAGRAM OF BOILER INSTALLATION SHOWING PUMP AND TRAP FEED

As a second way of feeding the boiler, would it be advisable to set a trap 4 ft. above the boiler and connect it with city water through a bypass around the pump and through the feed-water heater? Would we gain anything over the present system by using traps instead of pumps? How would it work to couple our hot-water tank to the cold-water line with suitable valves so that we cut down on the hot water if the temperature became excessive? This would also be gravity feed to pump. We are now raising water from 60 to 180 deg. and by taking water at 140 deg. we believe that we should get around 210 deg. Will our pump give trouble if the temperature of the suction reaches 180 deg. with a 5-ft. gravity head feed to pump? L. C. T.

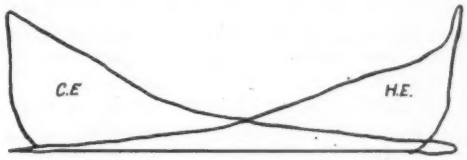
A. We have studied your problem and the diagram sent, and see no reason why you cannot put the feed water into your boiler through a direct return tilting trap. The city pressure should certainly be sufficient to force water through the feed heater into the trap, and the rate of feed can, of course, be easily regulated by the supply valve in the feed by leading to the trap.

As to the other connection from the hot-water tank to the pump at a temperature of 140 deg. for the water, it could be handled successfully with a 4-ft. suction lift; at 180 deg. the water would have to come to the pump under a 5-ft. head to avoid steam binding. We believe that by this change, you would be able to get water at from 190 to 200 deg., but we doubt if you could get up to 210.

As to cutting out the pump, the question arises, of course, whether you need the exhaust steam from this pump for either wash water or feed water. If you do, it will be cheaper to use the pump than the trap. If you do not, the trap method will be cheaper.

Four-Valve Atlas Engine Diagram

THE ACCOMPANYING indicator cards were taken from a 12 by 18-in. four-valve, shaft governed Atlas engine running at 235 r.p.m. on a steam pressure of 120 lb. gage. This engine was recently rebored and fitted with new piston and valves.



INDICATOR CARDS FROM AN ATLAS ENGINE

Please inform me what causes the sharp drop in head end admission line. What can I do to improve this card? I have tried reducing the lead, but it will then carry only half the load. H. M. R.

Suggestions for Improvements

THE INDICATOR CARDS submitted by P. F. in the Dec. 1 issue were taken when the engine was running non-condensing, judging from the position of the atmospheric line on the low pressure cards.

The high pressure card is fair; however, I think I would admit steam a little earlier at both ends, then balance the compressions. The crank end has now considerable more compression than the head end. The head end cutoff is longer than that of the crank end.

The low pressure card indicates that the steam valves are late in opening, the piston having moved about 5 per cent of its stroke before full boiler pressure acts. Advance the eccentric to give the valves more lead. Both exhaust valves are late in opening, but compression is good. The crank end of the low-pressure cylinder is doing considerably more work than the head end. Shorten the crank end and lengthen the head end cutoff in order to balance the load. Compression lines are not above reproach and it would be well to look for leaks.

TOM JONES.

An Omission

IN THE article on Chimney Design by Thos. S. Clark, which was published in our Dec. 1 issue, there appears, paragraph six, the statement: "Fire brick is often specified in the lining of self-supporting steel stacks where the temperatures do not exceed 400 to 500 deg. F." This statement should be qualified by the author's assertion: "It seems to me that this is not an economical thing to do, for a common brick or radial brick will answer every purpose under these temperatures."

"MAKING trouble for others is one way to put yourself in hot water."

POWER PLANT ENGINEERING

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Isolated Plant Development

Time was, and that well within the memory of the present generation, that when a demand for power existed such as required for the operation of a small factory, the usual procedure consisted of the installation of a complete steam plant. In fact, no other means were then avalable except, perhaps, in localities favored with small streams the energy of which could be harnessed and set to work. Both coal and labor, compared to present day costs, were exceedingly cheap and little thought was given to cost of production, efficiency of operation, etc. Continuity of service was of prime importance and as long as the wheels continued turning all was well.

Soon after the development of the incandescent lamp came the "electric light plant" which, for some few years, furnished electric energy for lighting purposes only. Then, as the electric motor, the polyphase alternating-current generator and the high-tension scheme of transmission and distribution of electric energy were perfected, a radical change came about. Where the demand for power was comparatively small, it was found more economical and more convenient to install a motor of the required size and obtain the energy from what was then not any more known as the "electric lighting plant," but from what as now is termed the "central station."

Then came the development of the central station. Improved steam producing and electric generating apparatus placed in the care of trained operators eliminated the wasteful methods of the early days and as a consequence the cost of production and therefore the rates for light and power were reduced to a minimum. Naturally, the effect of this was the gradual weeding out of the inefficient isolated plant.

This process was accentuated by conditions arising out of the World War. Not only did the rulings of the then existing Fuel Administration cause the shutting down of many of these plants, but because of the power rates fixed by the various state commissions and the abnormally high costs of all the elements entering into the cost of producing power, particularly in the smaller installations, competition became more keen thus forcing many otherwise efficient privately operated plants to turn to central station service in part if not entirely.

Apparently the isolated plant was to be forced out of existence. Happily, however, such has not been the case. Instead, engineers have of late given this vital and important subject more thought and consideration than ever heretofore, and instead of the elimination of the isolated plant, readjustment of this phase of our industrial life is now taking place on a sane basis.

Prejudice cannot be allowed to rule the situation. Only a thorough investigation and study of existing local conditions will suffice. True it is that in some instances sole dependence upon an isolated plant will prove the more satisfactory and economical; again, in other cases greater benefits will be derived by the use of central station service exclusively. As a rule, however, co-operation and co-ordination between these two sources of energy supply has solved the problem. In fact, such has proven to be the case in a number of most modern and recent installations.

In some of these the demand for exhaust steam for heating and manufacturing purposes is less than that capable of being supplied by the generating units when working at maximum capacity, and it is therefore obvious that greater overall economy is obtainable by the installation of electric generating equipment of such size as will provide only the required amount of exhaust steam and by the purchase of all that electric energy required in excess of the nominal rating of the electric generators. In other words, only generating units of such capacity should be installed as will meet the steam requirements. The surplus energy required should be purchased and can ordinarily be purchased at a rate such as will result in a greater overall economy than when the installed generator capacity is equal to the maximum demand for electric energy and the surplus exhaust steam wasted.

Again, conditions may arise such as exist in an automobile works of recent construction. In addition to electric energy considerable compressed air is used for the operation of pneumatic tools and paint sprayers, and as a consequence the installation of compressors becomes imperative. Investigation, however, revealed the fact that by employing electric generating units and either electrically operated or steamdriven compressors the exhaust steam available would be entirely out of proportion to the demand. Accordingly, the engineers in charge of the work found by careful analysis that the highest degree of efficiency and the greatest economy was to be had by the purchase of all of the electric energy and the installation of steam operated air compressors and plant auxiliaries. Thus it is evident that if in either of the cases cited central station service had been employed exclusively or a complete isolated plant installed, appreciable losses would have occurred.

As already many times stated in these columns, the central station and the isolated plant has each its particular field to serve—and frequently co-operation and coordination will prove beneficiary to all concerned. Until the production of power has been revolutionized, the central station will remain—so will the isolated plant.

Off Duty

"Is it possible that men can be so absurd as to believe that there are crops and trees on the other side of the earth that hang downward, and that men have their feet higher than their heads? If you ask them how they defend these monstrosities—how things do not fall away from the earth on that side, they reply that the nature of things is such, that heavy bodies tend towards the center like the spokes of a wheel. Now I am really at a loss what to say to those who, when they have once gone wrong, steadily persevere in their folly, and defend one absurd opinion after another."

So wrote Lactantius in the 4th century on "The Heretical Doctrine of the Globular Form of the Earth."

Lactantius, of course, maintained that the earth was flat as did practically everybody else. It was not until the beginning of the 16th century that the generality of men in Europe accepted the belief that the earth was round. This belief had been current among the more enlightened people of Greece at least four centuries before Christ, but to the others the earth was flat. It seemed preposterous to think otherwise. Ridiculous!

Power Plant Slogans

Keep and Analyze Operating Records in Every Power Plant.
Develop Water Power Sites.
Promote Health and Safety in Power Plants.
Handle Coal and Ashes Mechanically.
Employ Engineers for Engineering Work.

The earth, however, was not flat in spite of the absurdity of the theory. The voyages of Columbus and Magellan removed the last obstacles in the way of proof.

The theory of a round earth, however, was not the only theory which met with antagonism. In February, 1600, Bruno was burned at the stake for daring to assert his belief in a plurality of worlds. In January, 1647, Galileo finally escaped the talons of the inquisition when he died in poverty, blindness and disgrace for upholding the theory of a central sun with revolving planets. Such was the skepticism of mankind.

All of the theories which these men believed in are now established facts. We pride ourselves upon having made great strides in our concept of the universe and its workings, and so we have; but at the same time, we have not lost all of our medieval skepticism.

Today there are before the scientific world momentous questions, the true answers to which involve our most fundamental concepts—those of space and time.

Dr. Albert Einstein has come forth with an entirely new conception of material things. Space and time are entirely relative, and exist only in so far as they are relative to other bodies. The necessity for the existence of an ether is eliminated in his theory and according to his principle of independence of velocity, an absolute velocity cannot be detected by any means. Furthermore, according to his equivalence hypothesis, a uniform gravitational field of force is exactly equivalent to the effects of a uniform acceleration of the system considered when there is no gravitational field.

For instance, if we are riding up in an elevator, as long as it is moving up or down with a uniform velocity we feel the familiar effects of gravitation and our feet press upon the floor with normal force. If the elevator is accelerated upward we seem to weigh more, the force between the floor and our feet is greater and as far as we can observe, the effect is the same as though the force of gravity were greater. The ordinary effects of gravitation are, therefore, the same, as far as we can observe, as those that might be produced by acceleration.

Einstein's prediction of the deflection of the light of a star by the sun was observed by English astronomers in 1919, and the amount of deflection agreed with his prediction. His theory allows for the long unexplained oddity in the orbit of Mercury and his predicted displacement in the lines of the sun's spectrum have been found—all in agreement with his theory.

The evidence, at present, seems rather favorable to Einstein and before we label his hypothesis as ridiculous and absurd, let us keep in mind the lessons learned from the injustices rendered Galileo, Copernicus and Bruno.

Federated

COMPLETION OF THE ORGANIZATION OF THE FEDERATED AMERICAN ENGINEERING SOCIETIES AND THE AMERICAN ENGINEERING COUNCIL. CONFERENCE AT WASHINGTON OF REPRESENTATIVES OF 50,000 ENGINEERS. HERBERT HOOVER ELECTED PRESIDENT

AS A result of three years of work and planning to bring the engineers of the country together for co-operative work, representatives of twenty-nine national and local engineering societies with combined membership of over 50,000 met in Washington, elected officers and chose an Executive Board, and adopted Constitution and By-laws. The American Engineering Council is a going organization with Herbert Hoover, foremost of engineers in welfare and public service, as its president. As stated in the preamble, Federated American Engineering Societies and its managing body, American Engineering Council, is "A comprehensive organization dedicated to the service of community, state and nation."

HERBERT HOOVER, FIRST PRESIDENT, FEDERATED AMERICAN ENGINEERING SOCIETIES

So much work had been done by the Joint Conference Committee and the preliminary conference, that the business of the first meeting of Council, Nov. 18 and 19, was largely a matter of reviewing what had been done, deciding on last details and selecting the Executive Board and officers to carry out the plans of the Council.

It was a matter of no little regret to representatives that Richard L. Humphrey who has done tremendous work as chairman of the Joint Conference Committee was not able to act as a representative, since the society of which he is a member had not decided to join in the American Engineering Council. After calling the conference to order, Mr. Humphrey was given a vote of thanks and regret, and E. S. Carman, of Cleveland, was elected temporary chairman, with W. E. Rolfe, of St. Louis, as temporary secretary.

Committees were appointed as needed and the meeting adjourned to allow the committees to do their work.

As details of procedure are of little interest, it will suffice to give a résumé of the action taken at the various sessions. Examination showed that accredited representatives were present from the following member-societies: Alabama Technical Association; American Institute of Chemical Engineers; American Institute of Mining and Metallurgical Engineers; American Institute of Electrical Engineers; American Society of Agricultural Engineers; American Society of Mechanical Engineers; Cleveland Engineering Society; Detroit Engineering Society; Engineers Club of Baltimore; Engineering Society of Buffalo; Engineering Association of Nashville; Florida Engineering Society; Grand Rapids Engineering Society; Iowa Engineering Society; Kansas Engineering Society; Louisiana Engineering Society; Mohawk Valley Engineers Club; Society of Industrial Engineers; Technical Club of Dallas; Washington Society of Engineers; York Engineering Society; Associated Engineers of St. Louis; Taylor Society.

Also there were present representatives of participating societies which are giving favorable consideration to joining: American Institute of Architects; American Society for Testing Materials; National Fire Protection Association; Illuminating Engineering Society; American Society of Heating and Ventilating Engineers; Society of Automotive Engineers.

In the consideration of Constitution and By-laws, no material changes were made. The representative body, American Engineering Council, is composed of representatives of member-societies in proportion to membership. The managing body is an Executive Board consisting of a President, four Vice-presidents and a Treasurer elected by the Council, and twenty-four members chosen by representatives of national and local societies proportioned according to membership, local societies being arranged in districts for this purpose. For the present the districts are arranged as follows: No. 1, New England and New York State; No. 2, Michigan, Wisconsin and Minnesota; No. 3, Ohio, Indiana and Illinois; No. 4, New Jersey, Pennsylvania, Delaware, Maryland and District of Columbia; No. 5, all states south of the Potomac and Ohio rivers, with Louisiana and Texas; No. 6, all states not allocated to other districts. This arrangement is temporary and subject to revision by the Executive Board as membership increases. Three places on the Executive Board were left vacant so that societies joining before July 1, 1921, which will be admitted as charter members, may have representation on the Board.

Headquarters are to be in Washington, D. C., but meetings of the Executive Board will be held bi-monthly at such places as the Board may select.

The nominating committee reported for selections for officers: President, Herbert Hoover; vice-presidents, Calvert Townley, of New York, J. Parke Channing, of New York, William E. Rolfe, of St. Louis, and Dexter S. Kimball, of Ithaca, N. Y.; treasurer, L. W. Wallace, of Baltimore. This ticket was unanimously elected. The Executive Secretary is to be selected by the Board.

Members of the Executive Board selected by repre-

sentatives of Councils are as follows: American Institute of Chemical Engineers, Harrison E. Howe, of Washington, D. C.; American Institute of Electrical Engineers, H. W. Buck, New York, William McClellan, Philadelphia, Charles F. Scott, New Haven, Lewis B. Stillwell, New York; American Institute of Mining and Metallurgical Engineers, A. S. Dwight, New York, Edwin Ludlow, New York, P. N. Moore, St. Louis; American Society Agricultural Engineers, Samuel H. McCrory, Washington, D. C.; American Society of Mechanical Engineers, L. P. Alford, New York, Arthur M. Greene, Troy, New York, E. S. Carman, Cleveland, Fred J. Miller, Center Bridge, Pa.; Society of Industrial Engineers, F. E. Webner, Washington, D. C.; Taylor Society, M. L. Cooke, Philadelphia; Districts No. 1 and No. 2 not selected; No. 3, John F. Oberlin, Cleveland; No. 4, W. W. Varney, Baltimore; No. 5, O. H. Koch, Dallas, Texas; No. 6, L. B. Smith, Topeka, Kan.

The budget committee reported two schedules of expenditure, one the minimum, based on known receipts of $59,000 a year, and coming inside that figure, the other based on desirable activity for the Council totaling $92,500 a year, adjustment between these figures to be left to the Executive Board according to the amount received.

Resolutions of appreciation were passed to the four national societies and their Joint Conference Committee for work done in preparation for the organization of the Federated American Engineering Societies and American Engineering Council, and especially to Richard L. Humphrey, chairman of the Joint Conference Committee. Also to the resident engineering societies of Washington for courtesies received and to the technical and daily press for assistance and support.

The meeting concluded with an address by President Hoover on the Relation of Engineering Societies to Public Service and a reception and smoker tendered to the representatives by the engineering societies of Washington.

Power Reserves in the U. S.

SUPPLIES OF ENERGY AVAILABLE, RATE OF USE, LIFE OF RESERVES AND SOME FIGURES ON EFFICIENCY. BY GEORGE OTIS SMITH

HOW fast are we using up energy and reserves? How long can we go on? Are our uses justified? Are we using our reserves economically? These are vital questions for the welfare of future generations; and with present high and increasing prices of coal, they become of great economical importance.

For one thing, our power machinery equipment is not well loaded, as the average load factor is 14 per cent and the average time of working for prime movers 23.5 hr. a week. This is due to the nature of load on lighting plants and street railways, which piles up for a few hours a day and for which capacity must be provided.

Spite of the short week, we turn out 125 billion horsepower hours a year, of which 42 per cent is developed by public utility plants, 28 per cent by industrial plants, and 30 per cent by railroads.

For each individual in the country we use 6 t. of coal a year, of which 400 lb. goes for light in houses, 33 lb. for street lighting, 500 lb. for lighting of shops and factories, and the balance for heating, transportation and industrial power. Use has increased rapidly, for 50 yr. ago it was only 1700 lb. per person per yr., while now it is 13,000 lb.

As to reserves, it is interesting first to see what and where they are. Of water power of the world, 1/20 of that available is now utilized, half of this being in North America and one-third in Europe. Of the available water power not utilized, the largest part, 40 per cent, is in Africa, and Asia, North America and South America follow in order in amounts.

Of the coal reserves, North America has about half, Asia one-third and Europe one-sixth, the balance being scattered over other continents. And of petroleum, the continents in order of the amount of their reserves are North America, South and Central America, Asia, Europe, Oceanica, 60 per cent of the supply being 2 per cent of the world's area in the northern hemisphere.

The total amount of water-power available in the United States is 50,000,000 hp., if no provision is made for storage, and, if all developed, this would just about meet our present needs for power, allowing a 30 per cent load factor. *

Of coal, disregarding lignite, there is 2500 billion tons available, which if used for power alone would carry us for 7500 yr. at present average efficiency of use. While the petroleum wealth remaining is 7 billion bbl., which if used for power after taking out 40 per cent gasoline would produce our present power output for 9.25 yr.

These estimates do not take account of increased demands, and it is found that for the last census period the load on central stations increased 15.5 per cent, which will probably continue even more rapidly. On the other hand, we are bettering our practice, the record for the same period showing a gain of 7.5 per cent in efficiency of use of fuel. If we could bring all plants up to present best performance, it would mean that we would get eight times the power that we do by average practice from the fuel used.

As illustrations, one plant in Kentucky stated that it was getting a kw.-hr. for 37 lb. of coal but didn't think the result was quite what it should be; and in one Texas plant the output was reported as 30 kw.-hr. per barrel of oil, while good practice was showing 250 kw.-hr. per barrel. After examination and suggested improvements, the owner stated that he could well afford to employ the consulting engineer to fire the plant and then be ahead because of the savings effected.

Oil cannot, however, be considered as a large factor in power generation. As Mr. Eccles has stated, in the fuel field, oil compares with coal as does gold with steel among metals, and should be used accordingly.

Mr. Hoover has said truly that the bituminous coal industry is functioning badly at every point. Recovery of the coal in the mine is poor; transportation is bad, and the operation of mines is too irregular. Co-operation is needed of mine operators, railroads, large users of fuel and mine workers to bring the industry to a satisfactory condition. At present, coal, labor and heat units are wasted so that of a ton of coal in the ground the energy

*From an address delivered before the Chicago Section, American Society of Mechanical Engineers.

equivalent of only 76 lb. reaches useful work for the consumer.

Saving can be made in recovery from the ground and in power used at the mine, some 50 per cent of the mine power being saved by use of electric current. Also in the oil fields economy is increased by using hydroelectric power rather than oil fuel for pumping the wells, one company in California pumping 1100 wells in this way, or about 1/9 of those in the state.

In the use of fuel oil, the reserve is so small that it must be allocated to the most important uses, and certainly it should not be used where coal or water power can be had. It is even doubtful if we can afford to allow its use for ships, certainly not for locomotives. If used on sea, the best Diesel engines should be brought into service for tests on boats of like tonnage and service have shown that the Diesel equipped ship uses only 36.7 per cent of the oil required when it is burned under boilers to make steam for triple-expansion steam engines or turbines.

As to location of reserves, estimates give the center of gravity of supply of coal in eastern Nebraska, of oil in southern Colorado and of water power in central Wyoming. There may be no large supplies at any of these points, but the spotting indicates the direction in which industries may tend in the future to move.

Equipment of Electric Plant of Oshkosh Gas Light Co.

AMONG the problems of power plant design, is the selection of manufactured equipment which is best suited to the needs of the plant. The number and sizes of the principal units and the auxiliary equipment have a direct bearing upon the efficiency which can be maintained under operating conditions and inasmuch as these have become pretty well standardized the following list of equipment which is installed in the new plant of the Oshkosh Gas Light Co. of Oshkosh, Wis., will be found of interest as representing modern practice.

Boilers

3—500-hp. Edge Moor water-tube with Foster superheaters, Reliance safety water columns, Vulcan soot blowers, Westinghouse-Taylor underfeed stokers, set with Detrick front arch and Johns-Manville high temperature cement. Covered with Sil-O-Cel brick.

Economizers

2—Sturtevant with Edward relief vales, Sturtevant induced draft fans driven by Western Electric slip-ring, variable speed, 3-phase motors, 35 hp. each, and motor drive for tube scrapers. Steel I beam lift overhead for handling tubes.

Forced Draft

2—Buffalo turbo-conoidal fans driven at 1650 r.p.m. through Westinghouse reducing gears by Westinghouse turbines; speed controlled by Mason regulator.

Coal Handling

1—Pivoted bucket conveyer, capacity 60 t. per hour, driven by 3-phase motor——hp.

1—Robins belt conveyor, with self-propelling and self-reversing tripper, driven by ——hp. motor.

3—Richardson automatic coal scales with motor-driven undercut gate valves.

Boiler Control

1—Boiler gage board equipped with Foxboro recording instruments, Foxboro-Heath CO_2 recorders and Republic flow meters.

Stokers

3—Westinghouse-Taylor, 6—retort underfeed type, driven by Wachs vertical engines through sprockets, jack shaft, main shaft and clutches. Speed controlled by Mason regulator.

Boiler Feed

1—International Filter Co. water softener, reducing from hardness 15 to hardness 7.

3—Lea-Courtenay 2-stage centrifugal pumps, 300 g.p.m., 75 ft. head, 1750 r.p.m. driven by 10-hp. 440-v. 3-phase Western Electric motors, direct connected.

1—Davidson single cylinder steam pump, 12 by 7 by 12 in. with Fisher pump governor to control discharge pressure.

1—Lea-Courtenay, 5-stage centrifugal pump 275 g.p.m., 635 ft. head at 1750 r.p.m., driven by Western Electric 100-hp. motor.

1—Warren, o.p.p. steam pump, 14 by 8 by 16 in.

1—Hoppes open feed heater.

1—Low pressure centrifugal pump, 100 g.p.m., 100 ft. head, 1735 r.p.m.

7—9-hp. motors, Allis-Chalmers.

Generating Units

1—3000 kv.a. General Electric turbo-generator 4000 v. 541 amp. with Schutte & Koerting trip throttle, 3600 r.p.m., connected to size 14 Westinghouse-Le Blanc condenser with water and air pumps driven by a through shaft, having at one end a Westinghouse steam turbine driving through a reducing gear, 3500 to 700 r.p.m.; on the other end a Westinghouse, 3-phase, 100-hp. motor direct connected. Cooling water supplied by suction, and vacuum started by service from high pressure line or by a steam siphon into condensing ring.

1—1250 kv.a. General Electric unit 226 amp. 19 stage turbine, 3600 r.p.m. Condenser size 8 Le Blanc driven as above, 40-hp. motor.

1—750 kv.a. Allis-Chalmers unit 88 amp., 3600 r.p.m., with size 5 condenser steam and motor driven. 25-hp. motor.

Exciters

1—Motor-driven. Westinghouse unit 30-hp. motor, 440-v. 850 r.p.m., 25-kw. generator 125 v.

1—Turbine-driven through reducing gears 7200 to 1200 r.p.m. generator 50 kw., 120 v.

Rotary Converter

1—General Electric 750-v. a.c. to 650 v. 1250 amp., d.c. 1200 r.p.m.

Switch Board

1—Bench board for exciters, generators and station power; remote control with Westinghouse equipment.

2—Vertical boards for power and lighting, remote control with Westinghouse instruments.

1—Street lighting board for 5 circuits, 6.6 amp., 2200 v. with General Electric transformers and instruments.

1—Railway converter board, one panel for converter control, two feeder panels, three feeders each, Westinghouse equipment.

1—Station power main panel for 440 v., Westinghouse instruments.
1—Station house distribution board.

Transformers
2—General Electric C.C. type 6.6 amp., 2200 v.
1—General Electric C.C. type 6.6 amp., 1100 v.
3—General Electric 4000 to 750 v., 300 kv.a., c.p. for railway converters.
3—General Electric 4000 to 440 v., 100 kv.a., c.p. for station power.

Bus Equipment
4000-v. main bus.
4000-v. three section feeder bus.
4000-v. transfer bus.
All with oil break main switches and disconnect switches. Outgoing cables with choke coils and graded shunt resistance, multigap lightning arresters.

Gage Board
1—Boiler room with Foxboro recording instruments, Republic flow meters, Foxboro-Heath CO_2 recorder for each boiler.
1—Feed heater temperature recorder and flow meter for gas house main.
3—For generating units each with Ashcroft indicating steam and vacuum gages, Bristol recording vacuum gage, General Electric speed indicator, Homann & Maurer mercury column absolute pressure gage.

Valves
Pratt and Cady; outside screw cast steel for superheat; inside screw heavy body for saturated steam. Non return on boiler and superheater outlets.

Air Compressor
1—Westinghouse Air Brake Co. 9½ by 9½ by 10 in.

Blow Off Valves
3—Homestead plug valves.
3—Elliott Co. angle valves.

Large Automatic Substation for Cleveland

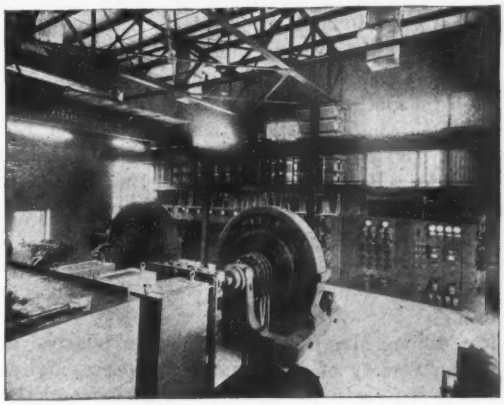
AUTOMATIC operation of large rotary-converter substations is now a fact in the installation and operation of a 3000-kw. station by the Cleveland Railway Co. This station, which contains two 1500-kw. rotary-converters together with transforming, switching, metering and control equipment, is the first of four stations to be installed which will take care of heavy traffic load outside of the main business section of the town.

In the past several years, there have been several automatic substations installed for use in small cities and for interurban lines. Nobody had attempted to adopt this apparatus for heavy city traffic because it was thought that several of the advantages gained by its use would not be had where substations had to be operated continuously a greater part of the 24 hr. Therefore, the installation of full-automatic equipment at Cleveland, the fifth city of the United States, is interesting because it shows the wide application of "laborless" equipment. The Heights Substation which was recently put in operation by the Cleveland Railway Co. is also distinctive because of its being the largest station with the largest units ever installed whose operation is to be left entirely to automatic operation.

The advantage of this equipment over manually operated apparatus is both in the solving of the labor problem and in the better operation that will be obtained. After the main alternating-current circuit breakers are closed it takes only about 40 sec. for the entire cycle of operation to be finished so that the machine can immediately assume load.

Besides being designed to take care of varying conditions, precautions have been taken to meet all difficulties that can be foreseen. For this purpose there are 18 protective relays, each one functioning as conditions for its use arise.

The new Heights Substation is taking care of city load which is outside of the two mile limit of the Cedar Substation and the load of the new Cleveland Interurban Railway Co. line which is being operated by the Cleveland Railway Co. The interurban line extends about two miles beyond the Heights Substation so that its load can be easily taken care of. In addition, the station will relieve greatly the load on the Cedar Substation which is in the most intensely populated residential section of the city.



INTERIOR VIEW OF AUTOMATIC SUBSTATION

The difficulty of obtaining proper maintenance men sometimes encountered in the installation of automatic substation equipment was obviated by the Cleveland Railway Co. in a manner that has proved most successful. When the stations were contemplated it was seen that several high-class men were desirable who would be well informed as to the lay-out of the station in order properly to find trouble and maintain the equipment. For this reason, L. D. Bale, Engineer of Substations, who has spent the past year and a half in the study of automatic operation, picked three likely men and initiated a school wherein he and the men studied very intensively, the complete working diagrams and schematic diagrams of the station. Questions were raised as to what would happen if a relay failed to operate or if certain conditions were present and the answers were obtained by actually working through the circuits. In addition, a separate wiring diagram was made for each piece of apparatus so that in case of trouble the exact cause could be located with the least difficulty and in the quickest possible manner.

The equipment for the four automatic substations

was designed by the engineers of the manufacturers, working in close conjunction with the engineers of the Cleveland Railway Co. In this connection, it is to be observed that the practical experience of the operating company proved to be of no little value to the designing engineers. In numerous instances, the engineers of the operating company were able to point out the need for protective devices and relays to provide for various operating contingencies. The manufacturer forthwith designed and constructed the apparatus with which to meet these needs.

Frank H. Ball

MR. BALL, whose name is so widely known among high-speed engine users as the designer of the automatic engine bearing his name, died in Detroit on Nov. 14, at the age of 74 yr. He made his start on an engineering career in a sawmill on his father's farm at Grand Island, from which he went into a shop where engines were built for drilling and operating oil wells, the Ball engine being a large factor in the development of the oil fields in Western Pennsylvania.

Later, Mr. Ball brought out the Ball automatic high-speed engine and founded the Ball Engine Co., of Erie, Pa., also the Ball & Wood Co., of Elizabeth, N. J.

Another company, the American Engine Co., of Bound Brook, N. J., was formed later to manufacture the American Ball Engine, and Mr. Ball became president and general manager.

After several years, he left the steam engine field, joining with his son, Frank O. Ball, to design and put on the market the Ball & Ball carburetor for gasoline engines.

For 40 yr. Mr. Ball was an active member of the American Society of Mechanical Engineers, and served as one of the early vice-presidents of that society. He was fond of sailing and won many races in Buffalo, Erie and Cleveland, but his great joy was the invention and manufacture of useful mechanical devices, and to this work his life was devoted.

Thomas W. Clarke

THOMAS W. CLARKE, engineer for the Standard Oil Co. of New Jersey, died suddenly in Tampico, Oct. 28, 1920. He was born in Roxbury, Mass., Oct. 21, 1872. He received his engineering education in Massachusetts Institute of Technology, and was highly experienced in both mechanical and civil engineering. On leaving college, he was associated for a time with Manning, Maxwell & Moore. During the Spanish-American war, he was an officer in the Navy and served as assistant to the chief engineer at the Mare Island Navy Yard and later as watch engineer on the U. S. Flagship "Philadelphia."

In 1902, Mr. Clarke became associated with the Standard Oil Co. as plant engineer of the Eagle works. In 1905, he was sent to China for the Standard Oil Co. of New York, where he was superintendent of construction and designing engineer in South China. In 1908, he returned to the United States and was assigned to the S. T. Baker Oil Co. to build a compounding and exporting plant for handling the Galena Oils. Later, he took charge of the construction of domestic trade plants for the Standard Oil Co. of New Jersey throughout the United States and Canada. In 1913, he left the service of the Standard Oil Co. to become vice-president and engineer of the New England Foundation Co.

During the recent war with Germany, he was traveling engineer in the Woodship Division of the United States Shipping Board. Later, he served as performance engineer for the Shipping Board on the Great Lakes. On leaving the Shipping Board, he returned to his home in Brookline, Mass., and served as traffic officer with the First Motor Corps, Massachusetts State Guard, during the noted "Boston Police Strike."

In February, 1920, he again entered the service of the Standard Oil Co., to do special engineering work for the general engineering department of the New Jersey Co. He was assigned to the Cia Transcontinental de Petroleo, S. A., and arrived in Tampico, March 1, 1920.

Mr. Clarke, in addition to attending to strictly company business in Mexico, promoted among the many oil companies operating in Mexico several projects including not only those improvements which would benefit the oil companies, but also those which would benefit the community at large. Among these projects were the dredging of the Chijol Canal, the increasing of Tampico water supply, improvements to Tampico and Tuxpam Harbors to minimize existing dangers to shipping, and the cleaning up of Tampico and Tuxpam to prevent an epidemic of yellow fever.

Mr. Clarke was a credit to his profession, a man of sterling worth and public spirited without peer. Even though a sick man, and against his physician's orders, he chose to remain in Tampico a few weeks longer; thus it was through his efforts to make Tampico and Tuxpam safe from yellow fever that he gave his life to humanity.

News Notes

THE STAR BRASS WORKS has established a Pacific Coast office in charge of L. M. Page, Rialto Bldg., San Francisco.

THE M. B. AUSTIN CO. moved its offices, on Dec. 1, from 700 W. Jackson Blvd., Chicago, Ill., to the company's new office building, 108 to 116 So. Desplaines St.

THE CHICAGO PNEUMATIC TOOL CO. has removed its rock drill plant from 864 East 72nd St., Cleveland, O., to the company's Boyer Pneumatic Hammer plant at 1301 Second Blvd., Detroit, Mich.

J. W. MURPHY CO., 108 S. La Salle St., is now acting as representative for Chicago territory for the Esterline Co. of Indianapolis. Mr. Murphy has, for several years, been sales manager of the Esterline Co.

C. B. MERRILL, who has been for a number of years in the general offices of the Economy Fuse and Manufacturing Co., has been appointed district sales manager of the Philadelphia office, 523 Widener Building, vice E. J. Watson, resigned.

AT THE FIRST meeting of the Executive Board of American Engineering Council in Washington, D. C., on Nov. 20, it was decided to appoint a committee to inves-

tigate Industrial Waste. President Herbert Hoover pointed out that there are three chief sources of loss in labor: unemployment due to industrial depression, change of employment from seasonal occupation and strikes. Activity of the committee will, in part, be directed to eliminating these factors.

Reorganization of the Department of the Interior into the Department of Public Works was favored.

Calvert W. Townley of New York and William E. Rolfe of St. Louis were chosen as vice-chairmen of the Executive Board.

THE ILLINOIS STOKER CO. announces the appointment of the Ernest E. Lee Co. as district representatives for Iowa, Wisconsin, Michigan, Northern Indiana and Northern Illinois with offices at 115 South Dearborn St., Chicago.

W. D. TYLER of Dante was elected president of the Virginia State Board for the Examination and Certification of Professional Engineers, Architects and Land Surveyors, at an organization meeting of that body, to succeed Prof. Fiske Kimball, of the University of Virginia, who resigned.

JEREMIAH SULLIVAN, for more than 30 yr. engineer for the Ellwanger & Barry Bldg., Rochester, N. Y., died at Spencerport on Nov. 19. Mr. Sullivan was born in Rochester 76 yr. ago, was a veteran of the Civil War, serving with the 54th Regiment, and was a member of the G. A. R. He also belonged to the International Union of Steam Engineers.

NORTHERN OHIO TRACTION AND LIGHT CO. is planning a new station to be built within 2 yr. on a site on the Muskingum River about 70 mi. south of Columbus. This includes a coal field and water power rights, power to be used chiefly for the industries of Akron. The cost of the land, coal, transmission and station of 100,000 kw. capacity is estimated to reach $15,000,000.

THE MISSISSIPPI RIVER POWER CO. has concluded a 20-yr. contract with the Central Illinois Public Service Co. for the delivery of approximately 10,000 hp., 3000 hp. to be taken at once, 1000 additional April 1, 1921, and the balance of 6000 to be taken over a period of 5 yr. The company is now delivering approximately 130,000 hp. under firm contracts, not including the new contract for 10,000 hp.

EMPLOYES of the U. S. Structural corporation of New York along the banks of the abandoned Erie Canal between Albany and Cohoes are erecting 40 steel towers, each 50 ft. high, to carry a high voltage transmission line. The work is being done for the Municipal Gas Co. of Albany at a cost of about $250,000. The line will be used to supply the Hydraulic Power Co. at Cohoes with electric current at times when the water in the river is low.

PERMITS have been taken out by the Diamond Match Co. for buildings to cost $213,000 in Springfield, Mass. The largest will be a power house to cost $110,000.

DAYTON, O., Power & Light Co. is to issue $1,000,000 of bonds to secure funds for enlarging its Miller's Ford plant and West Side substation. Demand for current has outstripped present capacity.

AUTHORITY to construct a huge dam and install an electric light and power plant on the Coosa River at Duncan's Riffle is asked in a petition filed by Thomas W. Martin, president of the Alabama Power Co., with the Alabama public service commission. Although it is not definitely known, it is estimated that the construction work contemplated will cost between $10,000,000 and $15,000,000. In addition to the dam and electric power house, the petition states the power company also contemplates the installation of transmission lines that will connect the new plant with the present system.

A LARGE power house is to be built for the International Paper Co. at Queensbury, N. Y., on the Hudson River, north of Glens Falls. Work will be done by the Parklap Construction Co.

N. G. GOUTY has been appointed engineer of the Spy Run plant of the Indiana Service corporation, and W. J. Maxwell, recently in charge of that plant, will take charge of the plant of the Chicago, Lake Shore & South Bend R. R. at Michigan City, Ind.

REQUEST has been filed with the Federal Power Commission by the Washington Irrigation and Development Co. to develop a power project at Priest Rapids, on the Columbia River in Washington, cost of the project to be $150,000,000.

THE CITY COUNCIL of Kingston, N. C., has approved a proposal to borrow $300,000 for the enlargement of its municipal power and lighting system. The city will issue short term notes, possibly for not more than one year, to bear 6 per cent interest.

INVOLVING a $2,000,000 power plant project, application for use of part of the natural flow of the north fork of the Stanislaus River has been filed with the recorder of Tuolumne Co., California. Application is made by Frank B. Pattee, of Oakdale, and Samuel Bernhard, of San Francisco, who contemplate the erection of a power plant at the headwaters of the river to develop about 9600 hp. Permission to store 21,933.59 acre feet of water from the Stanislaus between November and June is applied for and continuous use of 130 cu. ft. a second of the natural flow is also sought. Rights of the Utica Mining Co., of Angels, the Melones Mining Co., of Melones, and the Oakdale and San Joaquin Irrigation District are involved.

U. S. CIVIL SERVICE COMMISSION announces an examination, receipt of applications to close Jan. 4, for power house engineer to fill a vacancy at the United States Military Academy, West Point, New York, at $1200 a year, and vacancies in positions requiring similar qualifications, at this or higher or lower salaries. Duties of the appointee will be to take charge during his watch of the plant, consisting of boilers of 3000 hp. and 1500 kw. generating capacity, in Corliss d.c. machines and motor generation a.c. machines, and to make minor repairs. Applicants must have reached their twenty-fifth but not their forty-fifth birthday. Age limits do not apply to persons entitled to preference because of military or naval service. Apply for Form 1800, stating examination title.

U. S. Civil Service Commission announces an examination (receipt of applications to close Dec. 28, 1920) for junior physicist to fill vacancies in the Bureau of Mines, Department of the Interior, at $1560 to $1800, and vacancies in positions requiring similar qualifications, at these or higher or lower salaries. Appointees whose services are satisfactory may be allowed the increase granted by Congress of $20 a month. Efficient employes may be promoted to the position of assistant physicist, at basic salary of $2100 to $2200. Graduation from a college or university of recognized standing and at least 6 mo. experience in fuel-gas analysis and high-temperature measurements, are prerequisites for consideration for this position. Applicants must not have reached their fortieth birthday on the date of the examination. Age limits do not apply to persons entitled to preference because of military or naval service. Apply for Form 1312, stating examination title.

U. S. Civil Service Commission announces an examination for marine engineer to fill vacancies in the office of the Chief of Transportation Service, War Department, for duty in Washington, D. C., and throughout the United States, receipt of applications to close Dec. 28, 1920. Apply for Form 2118, stating the exact title (Marine Engineer, $3000 to $5000).

U. S. Civil Service Commission announces examinations for Associate Technologist, $2000 to $2800 a year, and Assistant Technologist, $1400 to $1800 a year, to fill vacancies in the Bureau of Standards, Department of Commerce, for duty in Washington, D. C., or elsewhere, at the salaries indicated, and vacancies in positions requiring similar qualifications at these or higher or lower salaries. Competitors will be rated in the following optional subjects, and applicants should state in answer to question 1 of the application form in which of these subjects they desire to qualify: rubber technology, leather technology, paper technology, textile technology, oil technology, general technology. Applicants must not have reached their seventieth birthday on the date of examination. Apply for Form 1312, stating examination title.

Trade News

The Miller Gas Engine Co., Springfield, O., has placed an order for a 300-hp. Smith gas producer to be used in the Miller plant on the testing floor.

Morse Chain Co., Ithaca, N. Y., manufacturers of the Morse "rocker-joint" silent chain, used on automobiles for power transmission, has established a Detroit branch factory, which will be devoted exclusively to the manufacture of silent chain sprockets and the Morse adjustment. The Morse Chain Co. will continue to manufacture chains and power transmission at the main plant at Ithaca. The Detroit branch will be under the general management of F. C. Thompson, with F. M. Hawley as chief engineer and C. B. Mitchell as factory manager. Sales and engineering offices are located at the Detroit plant, corner of Eighth and Abbott Sts.

In the monthly magazine Lubrication, issued by The Texaco Co., have appeared a series of articles on the more important industries of the country, showing briefly the manufacturing and industrial processes and discussing the special lubricating problems in each. Some industries so far treated are: Textile Manufacture, Sugar Refining, Metal Cutting, Rubber Manufacture, Refrigeration and Ice Making, Electric Street Railways, and it is understood that articles are in preparation on Paper Making, Machine Tool Manufacture, Steam Turbine Plants, Hydroelectric Stations and Marine Installations. The publication is sent free to those professionally interested in lubrication such as engineers, master mechanics, and executives or purchasing agents dealing with the subject of lubrication as a part of their work.

The Godfrey Conveyor Co., Elkhart, Ind., has just issued a new 16-page catalog. The Godfrey Conveyor System and the method of operation is fully explained in the first pages of the book, while the latter pages contain descriptions of a number of installations throughout the country. It is illustrated with numerous photographs and diagrams showing principles of the system.

Copies of the catalog will be sent to those interested upon request.

General Electric Co. Bulletin No. 46,209, second edition, describes Thomson direct-current astatic watt-hour meters for relatively large installations. Type CS is glass-inclosed, back-connected for switchboard use and has the standard, four-dial, fast-running register for daily or log reading. Type CS-3 is metal-inclosed with rectangular glass dial cover, arranged for front connections and has the slow-running register, house type, for monthly readings. Either type can be furnished for the other reading; also Type CS-3 can be supplied back-connected. The meters read direct in kilowatt-hours with multiplier of 10 or a multiple. Load adjustments are provided. The bulletin concludes with lists, diagrams and dimension drawings.

Like an old friend in a new dress, the new 1921 edition of Hendrick's Commercial Register comes to us this year in a bright attractive shade of red with black lettering. Some new features have been added, one of these is its simple method of arrangement and complete index, a feature which should appeal at once to the busy man. The publishers have added a page of directions entitled "How to Find Information," which gives in concise form detailed instructions as to the best way to find desired information. From this we note that the book is divided into five sections, the "Index to Trades," "Classified Trades," "Trade Names," "Alphabetical" and "Advertisers' Index." The purpose and use of each is fully explained. Another addition this year is a sheet of perforated post cards on which users of the book are urged to report faulty listings, wrong classifications and concerns which may have been omitted. On the whole, the new volume seems complete and a valuable reference in any wll organized purchasing or sales department.

Marine pumps and Auxiliaries Catalog BK-3000, just issued by Worthington Pump & Machinery Corporation, 115 Broadway, New York, consists of 125 pages of descriptive matter and illustrations. The catalog is divided into sections discussing respectively: (1) reciprocating pumps, horizontal and vertical, simplex and duplex, for boiler feed, fire and bilge, circulating and other water service; (2) air pumps and condensers; (3) oil pumps, cargo oil, fuel oil, lubricator oil, etc.; (4) centrifugal pumps; (5) miscellaneous marine auxiliaries.

ELLIOTT-EHRHART AIR EJECTORS

The Elliott-Ehrhart Air Ejector is a long step in advance of anything in its line. It is absolutely the simplest of all Air Ejectors in design—a conservative design based on years of experience—and this means simplicity in installation and operation.

Some of the interesting features of the Elliott Ehrhart Air Ejectors are as follows:

No oil or attendance required.

Little space required for installation as compared with reciprocating air pump.

No moving parts.

No bearings.

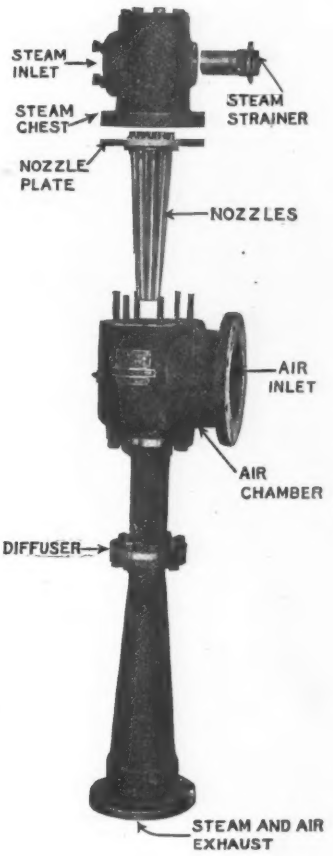
No maintenance.

Can be installed anywhere or any place.

No foundations required—cost of foundations eliminated.

Requires no fine alignment because there are no moving parts.

Elliott-Ehrhart Air Ejectors are furnished with all Elliott-Ehrhart Condensers—Jet, Surface and Barometric. When you are in the market for Condensers, let us figure with you on an Elliot-Ehrhart Condenser suitable for your requirements.



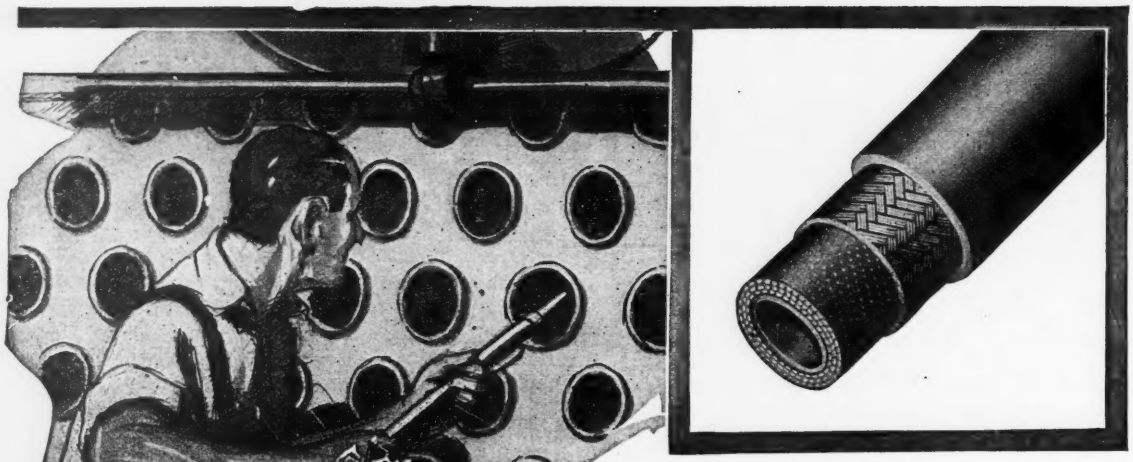
The illustration of a partially dismantled Air Ejector of the non-condensing type shows its extreme simplicity.

ELLIOTT PRODUCTS
Condensers
Air Ejectors
Twin Strainers
Twin Filters
Feed Water Heaters
Steam Separators
Receiver Separators
Blow-Off Valves
Oil Filters
Steam Traps

ELLIOTT COMPANY

Pittsburgh, Pa.

General Sales Office: Jeannette, Pa.



Steam Hose that Defies Heat

The compounding of rubber that will stand the heat generated by high pressure steam is a test of a manufacturer's skill.

Indestructible Steam Hose stays live and flexible—resisting the hardening or vulcanizing tendency of steam.

Note particularly the scientific construction of this hose. The seamless inner tube is covered with multiple plies of frictioned duck to which is applied the fabric jacket, woven directly on the hose by a special machine. This makes for great strength and a minimum of expansion under pressure.

The adhesion of the plies is preserved at its maximum strength—prolonging the life of the hose.

Secure protection against external injury is provided by the thick rubber cover, making wire winding unnecessary.

For Safety's Sake use Indestructible Steam Hose.

NEW YORK BELTING & PACKING CO.

Mechanical Rubber Goods

New York Boston Chicago Philadelphia Pittsburgh
St. Louis Salt Lake City San Francisco

Rubber Products for Power Plants

Test Special Rubber Belting
Conveyor Belting
Elevator Belting
Indestructible White Sheet Packing
Firo Superheat Sheet Packing
Cobbs Piston Packing
Double Diamond Pump Valves
Water Hose

INDESTRUCTIBLE STEAM HOSE

RUBBER GOODS
for the ENGINE ROOM

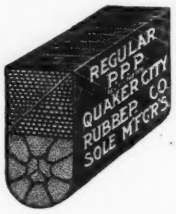
Without belting, packing, hose, gaskets, pump valves and many other rubber articles how long would your Engine Room run?

The vital importance of rubber is well known to every engineer and many a successfully operated plant is due to the wisdom in selecting the proper articles.

For years we have manufactured a complete line of Mechanical Rubber Goods especially suited for this class of trade. Specializing on Quaker City products is the best insurance for economical plant operation.

Daniel's P. P. P. Rod Packing

Long recognized as the most economical rod packing on the market. Unequalled for the packing against steam, water, air, ammonia and other fluids.



To meet the various working conditions where rod packings are used P. P. P. is made in the following forms:

REGULAR

For steam pressures of 100 pounds or less; ordinary water pressures, cold or warm; low ammonia pressures, valve stems, etc.

SPECIAL

For steam pressures over 100 pounds (when not superheated); compound condensing engines; high ammonia pressures; high hydraulics, very hot water; air pumps, valve stems, etc.

MARINE

For all pressures when superheated or dry steam is used. Marine P. P. P. must not be used for saturated or wet steam, the water end of pumps nor low pressure engines.

When P. P. P. is required for ammonia rods be sure to mention same, as ammonia packing is especially prepared for that purpose.

Rubber Belting

Our line of rubber belting embraces a full list of all sizes and plies made in a suitable number of brands to meet various transmission requirements.

IRONSIDES for main drives and hard duty. Where exceptional severe work is encountered this brand we particularly recommend.

QUAKER CITY is a thoroughly reliable belt. Equal to many first grade belts of other manufacture.

CROWN will give excellent results for ordinary transmission purposes.

Ebonite Sheet Packing

Used exclusively in many of the largest power houses, factories and machine shops, for high pressures, superheated steam, hot water, ammonia, oils, acids and all other kinds of joints requiring packing.

EBONITE will hold a vibrating joint absolutely tight, and where there is a varying expansion or contraction of the pipes, EBONITE is especially desirable.

Ebonite Steam Hose

An unusually sturdy hose with a seamless tube made of the same composition as our Ebonite Sheet Packing. The cover is tough and strong and will resist abrasion and wear under all ordinary conditions of use. EBONITE has no equal for steam purposes.

Rubber Pump Valves

We carry in stock or can make rubber valves for every purpose. If you are experiencing valve trouble give us the conditions under which you are operating and our experts will gladly recommend the proper valves for you to use.

Quaker City products are carried in stock by leading hardware and mill supply houses everywhere. To secure best results in the Engine Room insist on getting our brands.

QUAKER CITY RUBBER COMPANY

MANUFACTURERS OF MECHANICAL RUBBER GOODS

PHILADELPHIA	CHICAGO	PITTSBURGH	NEW YORK
629 Market St.	182 W. Lake St.	211 Wood St.	53 Murray St.

OVALHOLE

THE HOLLOW CENTER PACKING

The United States Patent Office granted patents on this packing July 20, 1915, as an improvement over all other fibrous packings. It is not an imitation and there is no other packing like it. Accept no substitutes.

"REGULAR"

This Style of Ovalhole Packing is known as "REGULAR" and can be used with success in more places than any other packing. It is recommended for all steam rods where the steam pressure does not exceed 125 lbs., for outside packed plunger pumps and elevator plungers. It is made in a special grade for ammonia service. If you have a rod or plunger that is badly worn or scored—try Ovalhole.

ASK YOUR JOBBER **ASK YOUR JOBBER**

THE HOLLOW CENTER PACKING CO.
1276 WEST THIRD STREET
CLEVELAND, OHIO.

Do You Get Real Lasting Service From the Packing You Use?

Or are you using one of those packings that is made to effect frequent sales?

There are packings and packings, many of which are sold only on price and require renewing so often as to be really expensive in the end, especially the labor cost of renewing the packing, which is the largest item of expense.

The engineer who uses a packing that gives long service under the peculiar conditions of his plant not only saves money for the owners, but avoids a lot of hard unnecessary labor for himself.

Our claim for

TRADE MARK
"PALMETTO" PACKING
REG U S PAT OFFICE

is that it is a packing with only one object in view—LONG SERVICE.

We can prove to you that "PALMETTO" will outlast the packing you are using if you will let us send you—without charge—working samples to test under your own conditions in your own way.

Write us at once, stating the size you wish.

Greene, Tweed & Co.

Sole Manufacturers

109 Duane St. New York.

Full of Life

Insist on Genuine GOETZE GASKETS and VALVE DISCS

See that the name GOETZE Appears on each. Accept no others.

GOETZE
Valve Discs

Made with a resilient core of high-grade asbestos covered with a copper shell they embody the maximum flexibility in seating.

Tightness is positively assured. Greatly superior to the best rubber composition. They do not rot, crack, or warp in service. Resist wear and abrasion to a remarkable degree. Their long lasting qualities make them by far the most economical valve discs to buy for your plant.

Corrugated Composition Metal Discs for ammonia, chemical and allied service.

Try them before you judge their merit—we allow you 90 days' trial at our expense to prove that they have no superior in any service.

Made for all valve sizes

Goetze Gasket & Packing Company
17 Allen Avenue
New Brunswick, N. J.

New York Branch:
242 Lafayette Street

Goetze corrugated copper or other metal with inlaid asbestos rings insure permanent tightness under all pressures and temperatures.

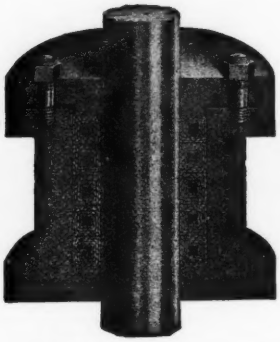
Skookum
always rides along on a *one-piece*, straight through ticket ~ Why fuss with a sectional packing that is always troublesome and ready to come to pieces? *Insist on* Skookum ~ the original Diagonal Cross Expansion Piston Rod Packing

There's a distributor in your vicinity. If not, write us. Test sample on request. Skookum is sold in Canada as Spando.

PIONEER RUBBER MILLS
[Formerly Bowers Rubber Works]
General Offices: **San Francisco**
Sales Offices: **Los Angeles, Denver, Salt Lake City Portland, Tacoma, Seattle**

Belmont Hollow Center Packing

Style No. 19



Belmont No. 19 under gland pressure in stuffing box. Undue pressure is taken up by the center hole. Expands under slight pressure enough to prevent leakage without excessive wear or friction.

←Holds Tight like this

Because of the Hole like this→

Cross sectional view showing the round hole which provides for expansion and contraction.

The hollow center is a refuge for excessive swelling and offsets the effects of expansion and contraction due to temperature changes. When the stuffing box is filled and the gland adjusted the result is just enough tightness to prevent leakage, but never enough to cause undue friction.

Another important economical feature of Belmont No. 19 Hollow Center Packing is that not only the upkeep but the initial cost per foot is lower because the "hole" weighs nothing and consequently the buyer gets more feet of packing to the pound.

For all purposes—Steam, Air, Ammonia, Hydraulics.

Write us about your particular packing problem. We'll help you solve it. No obligation on your part.

Write department M for our new general catalog No. 5 which describes and illustrates our entire line.

Belmont Packing & Rubber Co.

Main Office—Philadelphia, Pa.

New York, 99 Chambers St. Agencies in all principal cities Chicago, 38 N. Franklin St.

Trade "Flexitallic" Mark

The gasket that will positively take care of all expansion or contraction. This is **claimed** for several gaskets but we **guarantee** it.

We will send on trial any sized gasket that will fit your requirements.

"Flexitallic" GASKET CO., CAMDEN, N. J.

AKRO Metal Gaskets

Asbestos Ribbed

Guaranteed Five Years

A three-metal combination gasket corrugated deep with asbestos cords. Made for all steam pressures, especially high superheat.

Tear off, fill out and mail the coupon for a free sample.

AKRON METALLIC GASKET CO.

AKRON, OHIO

SMOOTH-ON ELASTIC CEMENT No3

For Tight Joints

Screw thread joints made with SMOOTH-ON ELASTIC CEMENT No. 3 are surely made, not "may be" made. SMOOTH-ON expands as it sets—seals the tiny irregularities that ordinary jointing compounds never catch. Order a 5-lb. can today from your Supply House.

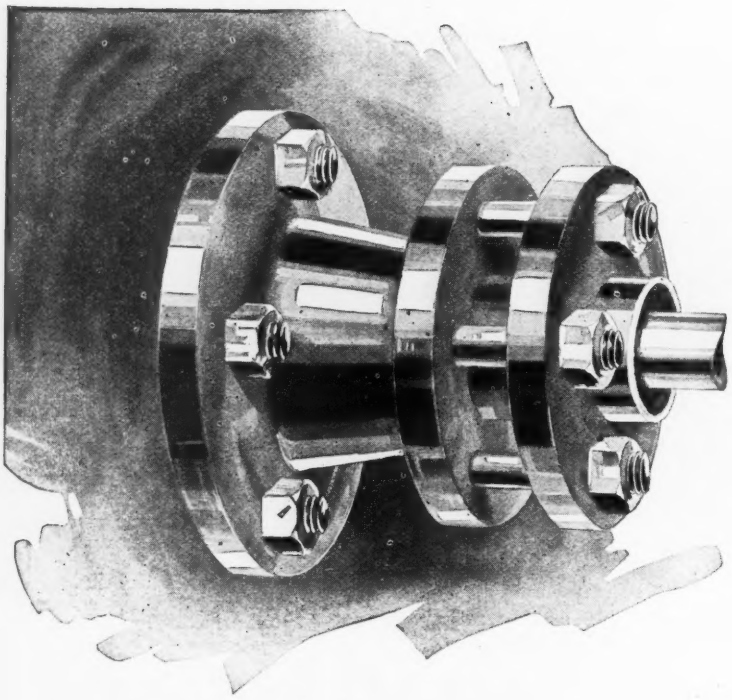
SMOOTH-ON MANUFACTURING CO.

ESTABLISHED 1869

570-574 COMMUNIPAW AVE., JERSEY CITY, N.J. U.S.A.

CHICAGO OFFICE 221 N. Jefferson Street

SAN FRANCISCO OFFICE 56 Sacramento Street



Want to cut the cost of packing rods and plungers? Read how.

Stuffing Box or Packing Retainer?

Why should most rod packing waste power?

THERE is a big difference between a stuffing box and a packing retainer, although common opinion may be to the contrary.

The difference is not in the device that holds the packing—usually termed a "Stuffing Box."

What you put into this device determines whether or not it is properly termed "Stuffing Box" or "Packing Retainer."

The reason that the question of "stuffing box" or "packing retainer" is well worth considering is because the cost of your power depends upon which are used in your plant or factory.

No device was ever better named than a stuffing box, because it is something in which material called packing is actually stuffed in a order to prevent leakage.

The Stuffing Box

The word "stuffing" generally signifies pressure, and so its use is proper in this case, not only because the packing is stuffed or pressed into the box, but because even if the gland is not screwed down tightly on the packing, the packing becomes compressed and is exerting pressure in every direction, because it expands under the action of heat or swells when saturated with a liquid. Ordinary packing in a stuffing box on account of this expansion is continually pressing against or gripping the rod, as well as the various parts of the container.

JOHNS-MANVILLE SERVICE COVERS THE CONTINENT

Through—

Asbestos

and its allied products

JOHNS-MANVILLE
Serves in Conservation

Heat Insulations, High Temperature Cements, Asbestos Roofings, Packings, Brake Linings, Fire Prevention Products

JOHNS - POWER PLANT

It is this pressure against the rod that prevents leakage, and so it must be great enough to prevent the maximum tendency of leakage. Furthermore, the pressure is constant—continuing at all times.

And so we say the term "stuffing box" is well deserved.

The Packing Retainer

If you place packing in a box and the packing is actually clear or free of the rod on account of its inside diameter being a little greater than that of the rod; if that packing was so designed that the action of temperature would not expand in against the rod and the action of the liquids would not swell and force it against the rod; and if the duty of the gland were only to hold the packing in the box, rather than to force it against the rod—does not the device or box that holds such packing in place deserve a better name than "stuffing box."

We believe it does. It is simply a holder, or "packing retainer."

The Difference

The packing in the stuffing box is forcing itself against or gripping the rod all the time. As a matter of fact it acts like and actually is a brake on the rod. Operating a pump, engine, compressor or other machine with this brake in continual operation is exactly analogous to driving an automobile with the emergency brake partially set. You rightfully think that the man who drives a car with the brake on is forgetful to say the least. He gets less power, less speed and consumes more gasoline—fuel.

So much for packing in the stuffing box.

The packing which goes into the packing retainer is free and clear of the rod and is exerting no pressure against it, but is so designed and constructed that when there is a tendency of leakage or a pressure through it a part of it *automatically* is pressed against the rod, thus preventing leakage.

It is the tendency of leakage or pressure through the box that forces the packing against the rod and so the grip on the rod is entirely proportionate to tendency of leakage, only maximum when necessary and this maximum is always the minimum required.

In other words brakes are applied only as necessary. Just as the automobile brake would be applied when driving down a steep hill.

Which are you for?

If you apply this line of reasoning to your pumps, engines and various power machinery, aren't you in favor of the "packing retainer" and operating with "brakes off," rather than the "stuffing box," which necessitates "brakes on."

"Brakes on"—all of the time, means not only a tremendous waste of power and consumption of fuel, but additional and unnecessary wear on packing, rod and machinery.

The actual cost of "brakes on" is hardly appreciated.

Why not pack automatically?

Thousands of engineers have packing retainers because they pack automatically and efficiently with JOHNS-MANVILLE SEA RINGS. Sea Rings are holding back steam, air, water, chemical solutions and other fluids in thousands of plants and accomplishing their purpose with least possible friction.

How Sea Rings operate.

The cut in the lower right hand corner shows the shape and design of a Sea Ring. A hard, stiff heel on the outside; a pliable lip on the inside and a hollow space between the two to allow for expansion or swelling and to provide a surface for the pressure to force the lip against the rod when necessary.

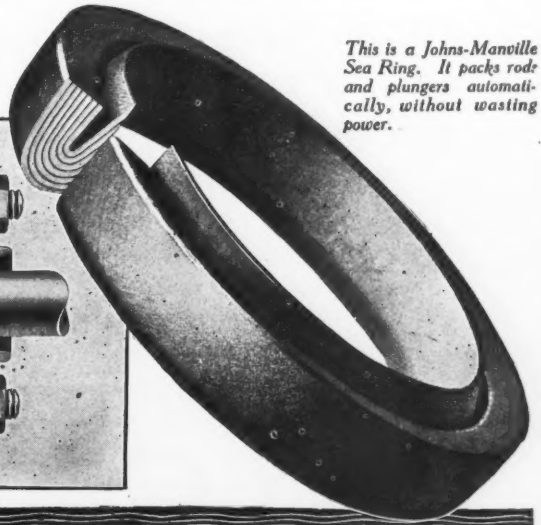
The pressure through the stuffing box and exerted on the lip, operates it. As the pressure increases or diminishes, the lips of Sea Rings hug the rod tighter or ease off accordingly.

And when there is no pressure they ease off entirely, —as on the forward stroke of an engine—during which Sea Rings are not pressing against the rod and not consuming unnecessary power.

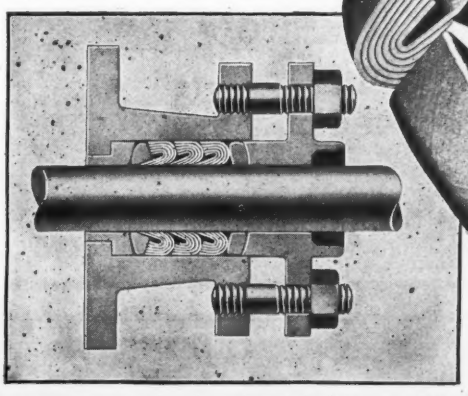
Because both the action and pressure of the lip are automatic, both the life of the packing and the life of the rod are prolonged.

We recommend that you take off the "brakes" on your pumps and engines, save power, save packing and make your "stuffing boxes" "packing retainers."

To do this we recommend that you use Sea Rings.



This is a Johns-Manville Sea Ring. It packs rods and plungers automatically, without wasting power.



How Sea Rings look in service. A cross-section of a "packing retainer," efficiently packed.

JOHNS-MANVILLE
Incorporated
Madison Ave. at 41st St., New York City
10 Factories—Branches in 64 Large Cities
For Canada:
CANADIAN JOHNS-MANVILLE CO., Ltd.
Toronto

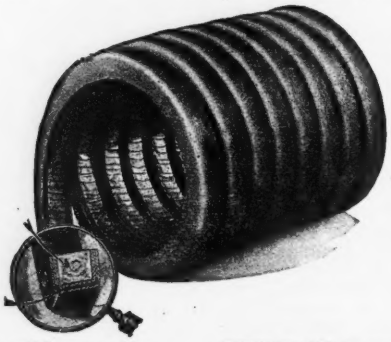
MANVILLE MATERIALS

Resilient Metallic Packing

for Plungers, Accumulators, Presses,
or Rods not in Perfect Alignment

"JOHN CRANE"
Babbitt Packing

Oil-Proof Resilient Cushion



"JOHN CRANE"
Channel Packing

The New Style 400

Plungers, rods or shafts subject to vibration or misalignment, or slightly fluted or scored, should be packed with STYLE 400, if you desire to save your equipment from further wear.

STYLE 400 is recommended for hot or cold water, pressures to 4,000 lbs. STYLE 400 is very successful on steam hammers, air compressors and ammonia compressors.

Specify STYLE 400 on your next order to your local Mill Supply House

CRANE PACKING COMPANY

General Office and Works: 1802 Cuyler Ave., Chicago

NEW YORK: 1536 Park Row Bldg. HOUSTON: 405 Scanlan Bldg.

CANADA: Flexible Metallic Packing Co., Ltd., Windsor, Ont.

"The best ever used"

That's what two users report. Many others from all parts of the country report equally as good results from

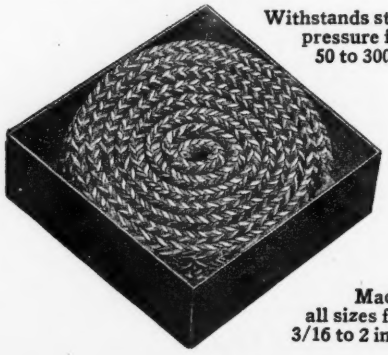
Strong's Grapho-Rivalate Metallic Packing

It is a Flexible Metal and Lubricated Asbestos Packing that will never carbonize or disintegrate under 1,000 degrees of heat.

Best on the market for steam engine rods and all 'round work. In coil form.

Fits all boxes of a given size.

Strong Machinery & Supply Co.
Dept. A, 21 Walker St., New York City



Withstands steam pressure from 50 to 300 lbs.

Made in all sizes from 3/16 to 2 in. sq.

VULCABESTON

"THE UNIVERSAL PACKING"
THE JOHNS-PRATT COMPANY, HARTFORD, CONN.

Red Fibre Sheet Packing

A New Approved Design

Have you received that descriptive matter on

HUHN "FLOAT CAGE"

the new piston-ring packing for steam and air.

AMERICAN HUHN METALLIC PACKING CO. Woolworth Bldg., New York.

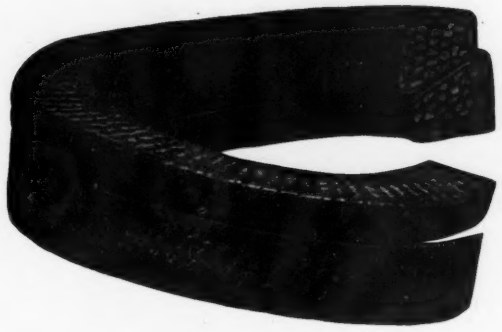
Saving Coal, Ammonia, Money

The more that is known about power plant economy the more important the matter of packing becomes. For example, it has been figured that a ⅛-in. hole will waste $640.80 in a year with steam at 150 lb. pressure.

FEDERALITE METALLIC PACKING

paid big dividends in stopping the leaks on high pressure steam, refrigerating and pumping services long before coal, ammonia and other materials went soaring upward in price.

Today it is holding tight in the plants where records and analysis are most closely kept because of its own record of permanency and superiority on ammonia, air, gas, high pressure steam, etc.



FEDERALITE PACKING saves enough in packing bills alone to compel your attention. But when you add to this the fact that it reduces friction to a minimum, never scores a rod, stands any known working pressure and is unaffected by heat up to 600 deg. F., it is surely time to give FEDERALITE a trial in your own plant.

Write today for the reasons why this packing is the choice of the U. S. Government and leading ice plants and power plants throughout the country.

Federal Metallic Packing Co.

48 Hanover Street, Boston, Mass.

Manufacturers of Federalite Metallic Packing in Ring, Twist and Spiral Forms; "Pactite" Shredded Metallic Packing and Federalite Pump Valves and Plunger Rings.

"SAFETY" PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

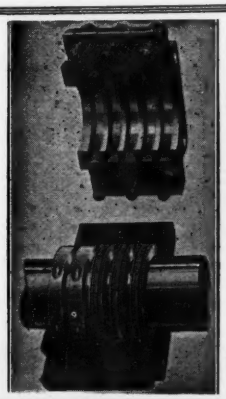
GUARANTEED TO LAST THREE YEARS

WITHOUT RENEWAL

Drop us a line and let us tell you all about this remarkable packing

Steel Mill Packing Co. Established 1899 **Detroit, Mich.**

AGENTS WANTED



No. 31-G—Gas Packing guaranteed against 1500 lbs. pressure. 2500° Fahr.

Tell us your Packing Troubles. We please others and can please you. Nothing too hard for us. 20 years experience—23 patents.

Holmes Metallic Packing Co.
Wilkes-Barre, Pa.

Ask for "Holmes" Pkgs.

The largest plant devoted exclusively to Metallic Packing in the world

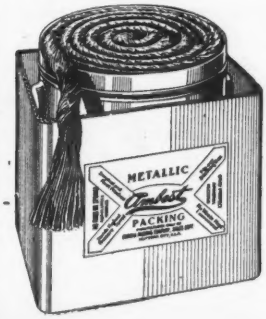
You can't "corner" it if the rod is true and in line

Ambest Flexible Metallic Packing

THE Packing for any pressure—
Highest to Lowest,
Air, Oil, Ammonia,
Temperature (to 600°), Etc.

AMBEST stands up and keeps on standing up against them all for years—

AMBEST is ACE HIGH on CONVENIENCE, too —EVERY SIZE IN ONE CAN—you only have to twist the long, lubricated strands to size needed and shove into the box and then add a little (as needed) during the LONG, LONG SERVICE AMBEST gives.



Please reward our energy in keeping after you by sending for a free sample of AMBEST for a SMALL TRUE ROD.

(Made by the makers of Eureka.)

Eureka Packing Company
79-81 Murray Street
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SUPERLA BRAND

Represents New Process Friction Reducing Oils

SUPERLA
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OIL

CYLINDER
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EVERY DROP COUNTS

Superla Brand Oils assure the highest degree of lubrication at minimum cost. Their adoption by leading industrial works of the world is the strongest proof of superior lubricating value and power saving properties

SOLE MANUFACTURERS

STANDARD OIL COMPANY

(AN INDIANA CORPORATION)

Lubricating Graphites

form a polished surface on bearings that reduces friction to zero. Graphite as a lubricant saves power, coal and oil, while increasing the efficiency of machinery.

Graphite forms a glass-like coating on the walls of engine cylinders, making them practically frictionless. For gas engines is used dry—for steam engines with oil.

Our Lubricating Graphites consist of the best material obtainable, refined by a special process, making a smooth, velvety lubricant which we guarantee.

Write for our booklet "Graphite Products."

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FOR MORE THAN 51 YEARS

Albany Grease has given a lubrication service of the highest type. Its incomparable record during the past 51 years stamps it as a most efficient and economical lubricant. That the fine lubricating qualities of Albany Grease have been appreciated is evident by the fact that more of it is used today than ever. Use Albany Grease on every bearing in your plant.

Samples will be gladly sent upon request.

Your Dealer Sells Albany Grease

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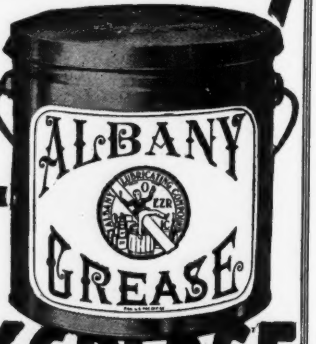
708-710 WASHINGTON ST., NEW YORK
Established 1868



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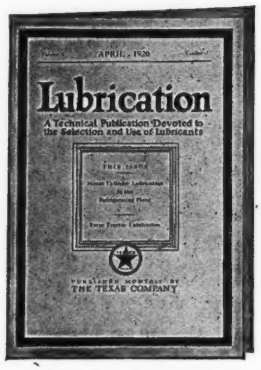
APRIL, 1920
Lubrication
A Technical Publication Devoted to the Selection and Use of Lubricants
PUBLISHED MONTHLY BY
THE TEXAS COMPANY

In this magazine we print month after month, articles covering the problems of lubrication as applied to various industries.

These articles are not theoretical, but based on practical operating experience.

We shall send "Lubrication" to Engineers, Executives, Buyers of Lubricants, and others, who are professionally interested and who ask for it—FREE—for the time being.

The timid old lady asked the Baggage Master if her parcel would reach 'Frisco intact.

Said that official—"Let's see."

Thereupon he threw it on the floor. Once—"That's for Chicago." Twice—"That's for Kansas City." Third—"That's for Denver." The fourth time—he dashed it on the floor with extra violence. The contents were scattered about.

"You see, mum, it wouldn't reach."

Fortunately, you Engineers are not in that position. You do not have to risk a trial of the various operating accessories in YOUR plant. You can pick out a well-known article, one that has been tried and tested for years under actual working conditions in OTHER plants.

Among such tested products are TEXACO LUBRICANTS. Their success in thousands of plants have secured them the recognition to which their careful preparation and their suitability for the purpose entitles them.

Whether you use steam, electricity, or gas, whether you operate engines, hoists, ice machines—anything—there is a TEXACO LUBRICANT for you—

"The *right* oil for the *right* place"

Get **"Lubrication"** *free*

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Offices in Principal Cities

Kindly put my name on your free mailing list for "LUBRICATION."

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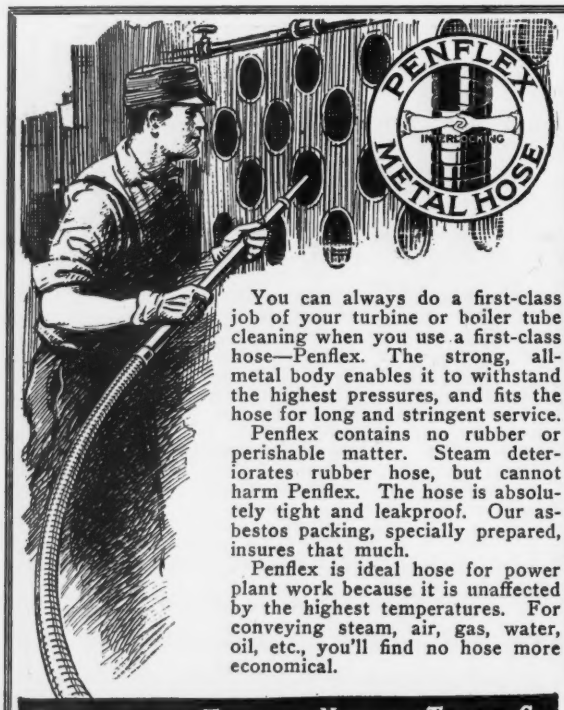

You can always do a first-class job of your turbine or boiler tube cleaning when you use a first-class hose—Penflex. The strong, all-metal body enables it to withstand the highest pressures, and fits the hose for long and stringent service.

Penflex contains no rubber or perishable matter. Steam deteriorates rubber hose, but cannot harm Penflex. The hose is absolutely tight and leakproof. Our asbestos packing, specially prepared, insures that much.

Penflex is ideal hose for power plant work because it is unaffected by the highest temperatures. For conveying steam, air, gas, water, oil, etc., you'll find no hose more economical.

PENNSYLVANIA-FLEXIBLE-METALLIC-TUBING-CO.

COR. BROAD & RACE STS., PHILADELPHIA, PA.—WORKS: 72ND & POWERS LANE, WEST PHILADELPHIA.

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U. S. FLEXIBLE METALLIC TUBING CO.
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Insure Your Power House With a

Castle Liberty No. 1

Active sales representatives desired for unoccupied territory.

Insurance policies **do not** put out fires. They only pay for the damage done by the fire. The delay caused by having to rebuild or repair damage done by fire often costs more than the Insurance Company pays.

Avoid this delay by equipping your Power House with the **New Exclusive CASTLE LIBERTY No. 1**, a Three-Gallon Carbon Tetrachloride Type, Hand Pump Fire Extinguisher which has sufficient capacity to extinguish almost any fire apt to happen around a Power House.

Comparative and competitive tests have proved that a **CASTLE LIBERTY No. 1** can extinguish fire that could not be controlled by twenty-eight one-quart fire extinguishers.

The extinguishing agent is Castle Liquid approved for Government use and used by leading Corporations, Railroads and Governmental Departments.

Write for complete description. Write for "Safety Always" telling the real story of fire extinguishing liquids. It tells you why so many one-quart extinguishers are out of service by reason of corrosion and it tells you how Castle Liquid corrects this trouble.

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Manufacturers and Distributors of Fire-Extinguishing Apparatus.

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The Paramount Lubricant

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Sets a Supreme Standard by Which All Others Are Judged

The line includes a grease for every purpose, and it's sure to be much better than you can buy elsewhere at any price. Let us send samples.

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GREASE

Makes the most efficient equipment more efficient

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TRADE MARK REGISTERED IN **NON-FLUID OIL** UNITED STATES PATENT OFFICE

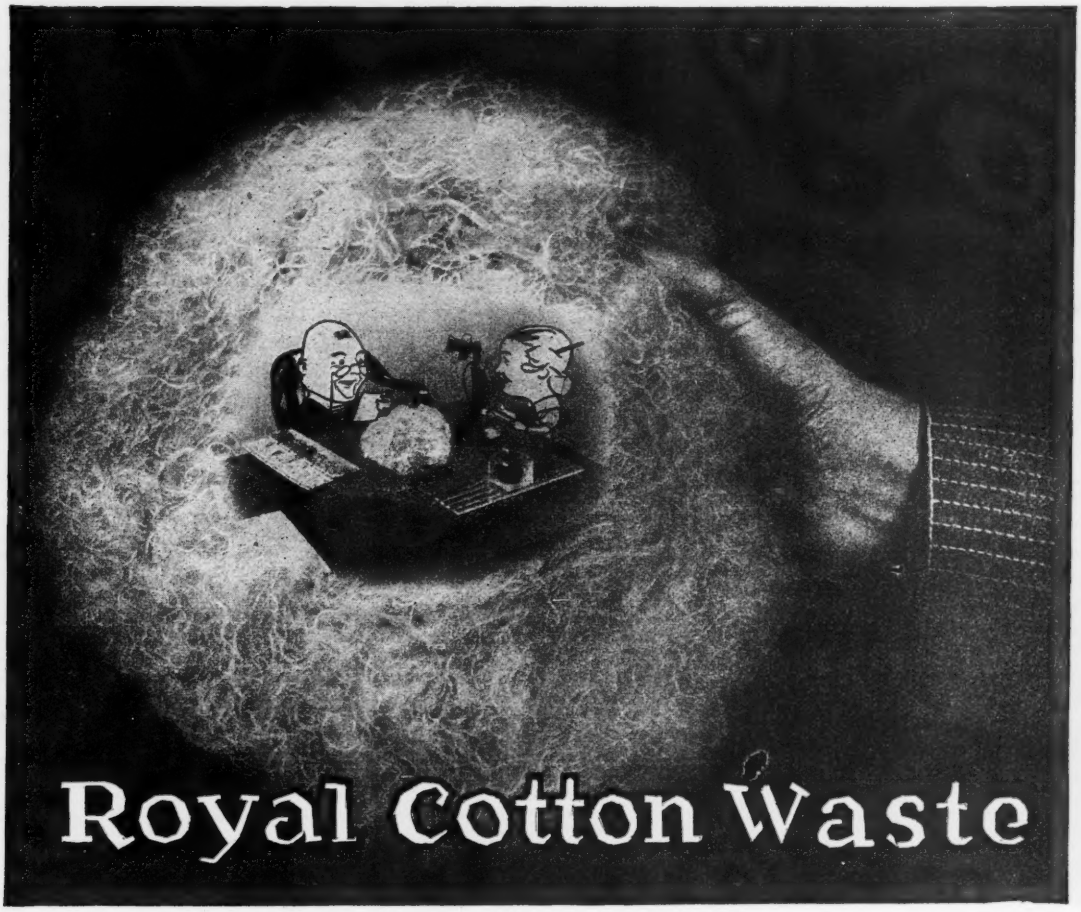
GREASE DEFEATED by excess friction—too little lubricating quality.

FLUID OIL DEFEATED by waste—it didn't stick to its job.

NON-FLUID OIL lasts much longer than either oil or grease—less lubricant required—costs less.

Longer intervals between lubrication means less labor cost.

New York & New Jersey Lubricant Co., 401 Broadway New York



When Royal Comes To Work

BUYERS of Royal Cotton Waste have very definite reasons for their selection and equally definite proofs that their reasoning was correct. Take a handful of Royal from any lot or any bale and check it up with the sample you picked from the Royal Sampling Catalogue. You will find always that the Waste received is identical in ingredients, quality and work power with the Waste you ordered. Royal is standardized for uniformity.

Ask your Jobber or us for the Royal Sampling Catalogue and the booklet "Clean Clean Thru."

SMALL USERS SHOULD ASK TO BE SHOWN
THE HANDY NEW ROYAL AUTOPAK BALE

ROYAL MANUFACTURING Co

General Offices & Mills
Rahway, N. J.

ROYAL COTTON WOOL WASTE — OUR WASTE IS YOUR GAIN

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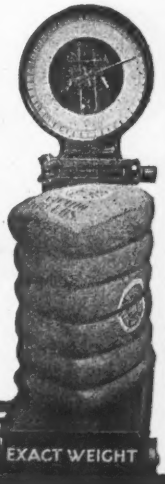


THE GUARANTEE: Uniform Quality 6% Tare (Wrappings) Exact Weight

Extra Heat At No Cost

The Maintenance of

The Ellis Automatic Tilting Steam Trap

can be considered negligible, whereas the increase in boiler capacity and fuel saving averages 10 per cent.

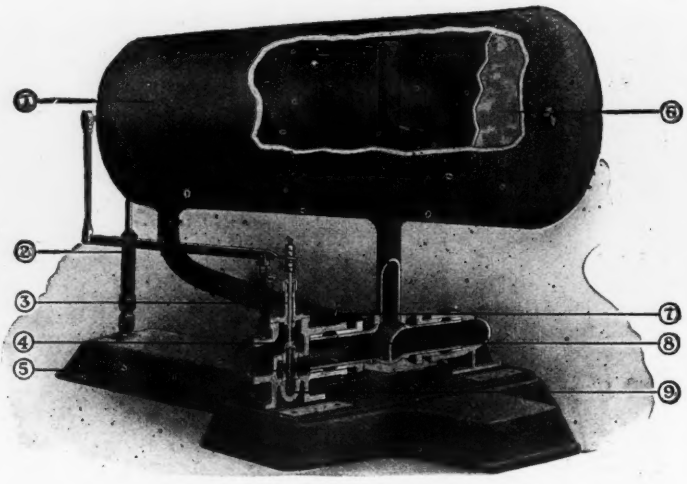
Operation only requires a quarter of the steam it takes to operate a boiler feed pump.

Design is attractive in appearance and extremely simple.

These features prove a distinctive help in meeting present-day conditions with ability to master them.

The Ellis Automatic Tilting Steam Trap is manufactured in four types, Direct Return, Lifting, Vacuum and Separating. Write for further information.

The Ellis Drier Company
336 S. La Salle Street, Chicago, U. S. A.



1. The receiver tank of Armco Iron tested with hydrostatic test of 450 lbs.

2. The shock absorber is composed of two tempered springs.

3. The valve stems and fittings are polished monel metal which prevents valve sticking, scale and corrosion.

4. All valves are equipped with Jenkins renewable discs.

5. The ends of the trunnion are faced and turn in removable brass bushings.

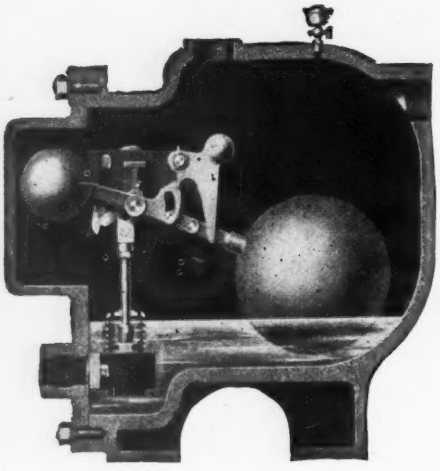
6. The counterweight is placed inside of the tank head and is adjusted in the factory.

7. Valve bonnets are cast brass and clevises are machined from solid brass bars.

8. The trunnion is nickel plated manganese bronze.

9. The valve bodies are cast semi-steel, tensile strength 36,000 to 38,000 pounds.

50% to 100% Larger Discharge Capacity Than Any Other Trap



No dependence whatever is placed on the buoyancy of the float to lift the WYOMING'S discharge valve from its seat, as is the case in all other float or bucket traps. The float is instrumental only in releasing the valve weight which, in dropping, lifts the discharge valve. This is the reason that the capacities of the WYOMING are so much greater than other traps which depend on float or bucket to open the valve.

WYOMING STEAM TRAPS

Positive discharge — non-wire-drawing, water-sealed discharge valve. All working parts are attached to the cover, which can be easily removed.

Full details in Catalog 18.
Shall we send you a copy?

Agents: The Andrews-Bradshaw Co.

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Leader-News Bldg., Cleveland
Adams Express Bldg., Chicago
F. W. Hay & Co., Reliance Bldg., Kansas City, Mo.
S. D. Merton, Pierce Bldg., St. Louis, Mo.

W. H. Nicholson & Co.
120 Oregon Street Wilkes-Barre, Pa.

(A Bundy Trap Pays for Itself Three Times in 12 Months.)

It was in a school building. The main steam supply was through a 6-inch pipe and the condensation had always been trapped and discharged to waste.

A Bundy Tank Trap of the Smallest Size

(⅜-inch) was installed and piped to discharge that "waste" condensation from the trap through coils in a plate warmer where live steam had previously been used.

The small Bundy Trap got the condensation out of that big pipe and put it to work while it was still hot—hot enough to do what had always required live steam before—hot enough to save $60.00 a year.

Bundy Steam Traps save more Money and save money in more ways than you can imagine.

Probably some of the Bundy's saving ways can be used in your plant right now. Your trap problems may suggest some new applications of these time-tried, profit-proven Bundy principles. Anyhow, it will cost you nothing to have us study them, from an engineering standpoint, and tell you exactly how much or how little the Bundy can do for you, and at what cost.

We sell Bundy Traps on definite guarantees. That's one reason why we cannot afford to deceive either you or ourselves through the Bundy Service (free) on which our guarantees are based.

"E" Write at once for Catalog "E"—the newest and, so far, the most valuable of all the "Bundy Books," as our catalogs are so often called.

Nashua Machine Company, 103 Main St., Nashua, N. H.

BRANCH OFFICE Boston 127 Federal St. Philadelphia Pennsylvania Bldg. NEW YORK 74 Cortlandt St. Baltimore Equitable Bldg. Pittsburgh Park Bldg.

IRVING SUBWAY TRADE MARK (PATENTED) THE FIREPROOF VENTILATING FLOORING

IRVING SAFSTEP TRADE MARK (PATENTED)
ABSOLUTELY NON-SLIPPING ALWAYS

SAFE—ALL THE TIME

The non-slipping feature of the **Irving Safstep** is an inbuilt quality permanently inherent in the structure and, therefore, continuing throughout the life of the step. It is not secured by special treads or abrasive insets—time and wear do not affect it. Indoors, with oil or grease or soap upon it—outdoors, with water, snow or ice upon it—the **Safstep** is always a safe, non-slipping step. And each step is a self-contained unit, easily and cheaply built into a ladder or stair. Let us send Catalog 2A15.

IRVING IRON WORKS CO.
LONG ISLAND CITY, N.Y., U.S.A.

Workers in Iron and Steel to Quality Standards and Manufacturers of

IRVING SUBWAY TRADE MARK (PATENTED) REG. U.S. PAT. OFF.
THE FIREPROOF VENTILATING FLOORING

Priceless in Service

Nothing in the way of the best has been spared in building into the American Ideal Steam Trap such quality as fits it to meet the severest of modern pressure requirements. The Float alone, in some of the largest sizes, costs more than an entire trap of the ordinary type. But the work that the

American Ideal Steam Trap

does, places it far above any money consideration.

Savings established by unending trouble-proof, wear-proof service makes the American Ideal the Trap purchase of ultimate economy regardless of first cost.

Made to operate on pressures up to 295 lb. Write today for valuable booklet.

American Steam Gauge & Valve Mfg. Co.

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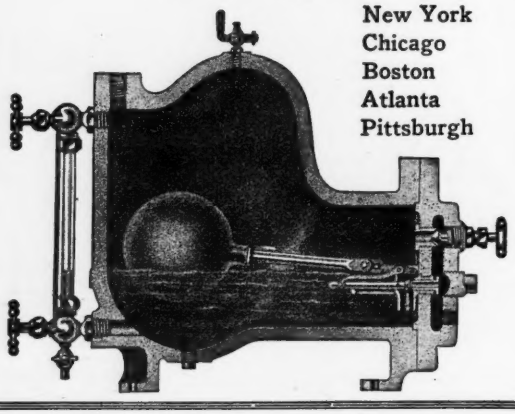
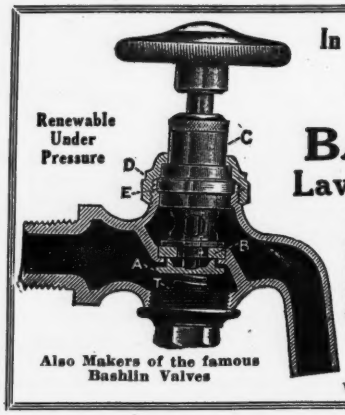
Pittsburgh





In the World's Largest Office Building
(The Durant, Detroit) only

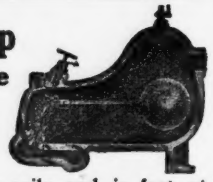
BASHLIN
Lavatory Fixtures

will be installed. The famous **BASHLIN Faucets**, of course, will form part of the equipment, because of their acknowledged superiority. Send for one for a free trial. Catalogue on request.

THE BASHLIN COMPANY
Warren, Penn. U. S. A.

Also Makers of the famous Bashlin Valves

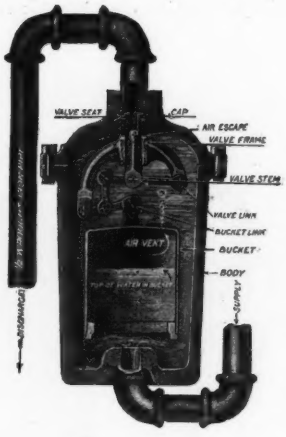
McDaniel Steam Trap
for High or Low Pressure



The Trap that holds the Steam and removes all condensation from the steam pipes, steam cylinders, steam coils, jacketed kettles, steam separators, heating coils, and, in fact, at any point where water of condensation will collect. Steam can't blow through, they have large discharge valves and cannot be flooded with sudden flushes of water. Send for our yellow booklet that will tell you more about the Trap, or better still, let us send you one on 30 days trial and you can see what a steam saver this Trap is. They pay for themselves.

Watson & McDaniel Co., 148 N. 7th St. Philadelphia, Pa.

A Dependable Steam Trap



If you, Mr. Engineer, question the existence of such a device let us call your attention to the

Armstrong Steam Trap

Send for our catalog "C"—read it over—you will then, at least, admit the Armstrong Trap is different.

We will welcome a trial under your worst conditions. If the trap doesn't make good send it back—we will pay all transportation.

Armstrong Machine Works

310 Maple St., Three Rivers, Mich.

Steady Automatic Operation of the Anderson Model "D" Steam Trap

—will help make possible the steady, economical operation of any power plant.

Without it you cannot properly drain, in the most time-saving, labor-saving, money-saving way, the condensation from steam coils, radiators or steam jackets.

It operates automatically and continually without permitting the slightest leakage of steam or scoring of valve, or interfering in the least with the proper, easy working of operating mechanism.

No early renewal of parts or constant re-seating of valves required if you use the **Anderson.**

Somewhere near you is a plant using **Anderson Specialties.** We'll be glad to refer you to that plant.

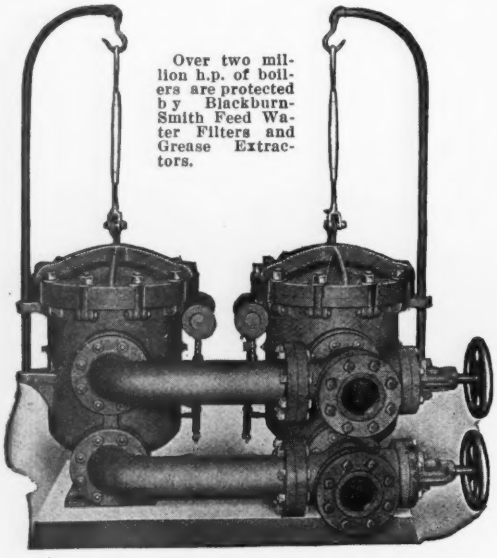
To use **Anderson Devices** is to profit by them. Write for catalogue.

The gauge glass on the outside tells you immediately if the trap is working properly or not.

The V. D. Anderson Co., 1937 West 96th Street, Cleveland, Ohio

STOCK CARRIED BY THE FOLLOWING AGENTS:

330 Manhattan Building, Chicago 537 Race Street, Philadelphia 207 Union Trust Building, Baltimore 100 Pearl Street, Boston



Over two million h.p. of boilers are protected by Blackburn-Smith Feed Water Filters and Grease Extractors.

The Blackburn-Smith Feed Water Filter and Grease Extractor

TWIN-TYPE

The Blackburn-Smith Feed Water Filter and Grease Extractor is removing oil and suspended matter effectively in numerous plants operating part of the twenty-four hours of a day.

The **Twin Type** of this apparatus should be used in plants operating continuously or where the quantity of oil or other suspended matter is excessive, because one side prevents any dirty water reaching the boilers while the other is being cleaned.

The exclusive feature of double filtration through separate surfaces, which makes the Blackburn-Smith Filter superior to all others, is, of course, retained in the **Twin Type.** The valve arrangement is simple, compact, and positive under all conditions.

As each filter is carefully tested under pressure, it is unlikely that any part will go wrong, but should repairs be necessary either body can be removed from the valve chambers without stopping the operation of the filtering system.

Send for Bulletin F-51

The BLACKBURN-SMITH CORPORATION

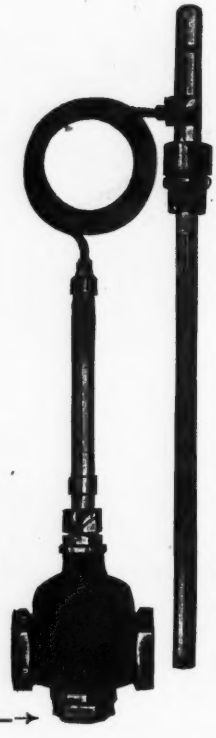
109 W. 40th St., New York City

Agents in All Principal Cities of the United States and Canada

173

Sarco

Temperature Control



Connection tube of any reasonable, desired length, between the thermostat and the valve.

Adjustment head. Regulators are calibrated for any desired temperature from 30° to 300° F. User can reset within a lesser range, as needed.

Valve operated by the expansion of the oil in the thermostat conveyed through the flexible tubing shown above. Valves are made to open on rise of temperature, or, to close, as desired.

Thermostat consisting of a tube filled with oil. When inserted in any tank an increase in the heat of the surrounding liquid expands the oil and this expansion operates the valve.

Sarco Temperature Regulators are supplied for tank control and room or kiln control.

Sarco Temperature Regulators are self-contained and self-operated. They require no electricity or compressed air.

Sarco Temperature Regulators save in first cost, save in installation and save in operating cost.

Sarco Temperature Regulators save labor and save the product.

Sarco Temperature Regulators are supplied on 30 days' free trial.

Write for Booklet No. B-52.

Sarco Company, Inc.

230 Broadway New York City

Ellicott Square, Buffalo.

6523 Euclid Ave., Cleveland.

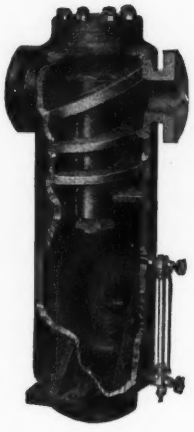
Drexel Building, Philadelphia.

Representatives in all principal cities

Majestic Building, Detroit.

Monadnock Bldg., Chicago

DRY AIR
SPEEDS UP
PRODUCTION



If your pneumatic tools are not functioning properly production is retarded. Water in the air may be the reason.

Remove it by installing a

Stratton Air Separator

The air will then go into the tools perfectly dry. Moist air also has a tendency to freeze during cold weather. The Stratton Air Separator prevents this.

Send for Bulletin No. 1111

The Griscom-Russell Company

2141 West Street Building, New York

Philadelphia	Pittsburgh	Chicago	New Orleans	San Francisco
Boston	Cleveland	Minneapolis	Houston	Seattle
Hartford	Toledo	Milwaukee	Fort Worth	Los Angeles
Springfield	Detroit	St. Louis	Charlotte	Kansas City

Figure Engine Performance on the Dry-Steam Basis

Don't blame your engines for inefficient service when you are admitting moisture-laden steam to the cylinders. Give them dry steam and watch them respond with better service. You can't do better than to put a Hoppes Separator on your steam line.

But why Hoppes?

Because it will eliminate the maximum amount of condensation from the steam. The area of the smallest port is much larger than the area of the steam line, hence the steam passes through the separator very slowly and it is a scientific fact that as the velocity of the steam passing through the separator is decreased, the efficiency of separation is increased.

You can rely on your engines getting dry steam when Hoppes Separators are close by, and we repeat, you should judge their efficiency on this basis only. There are no obstructions to prevent the easy, free flow of steam—in fact, the Hoppes embodies only the essentials necessary to the best of service.

There are several different types.

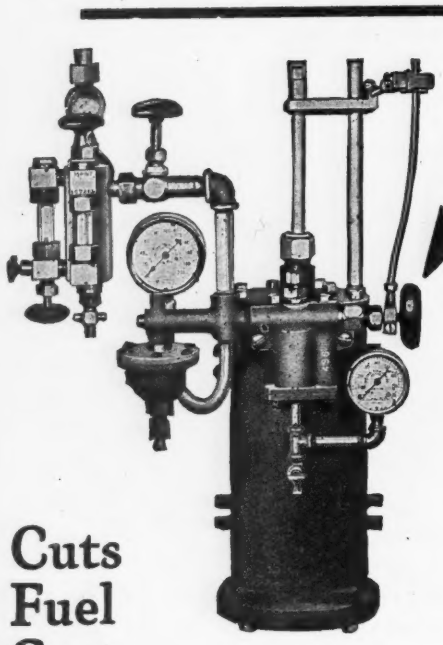
Get in touch with us regarding them. We'll be glad to tell you more. Write us NOW.

Hoppes Manufacturing Company

70 Larch Street **Springfield, Ohio**

We also manufacture Feed Water Heaters, V-Notch Water Meters, Live Steam Purifiers, Oil Eliminators and Exhaust Heads.

The Latest in Damper Regulation—Graduated Action



Follow the arrow and note the new compensating device which perfects

The "A-JACKS" Damper Regulator

The value of graduated action is well known in connection with feed water regulation. The advantage in damper regulation is fully as great. Particularly in plants where the load varies, it is most valuable to open and close the dampers gradually so as to prevent sudden draft from blowing holes in the fire bed or permitting combustion gases to escape. It can be set to operate full stroke on 1-10 lbs. steam or any other variation desired.

If you have an "A-Jacks" we can furnish you this compensating attachment. If you haven't one, get one. It's a great little fuel saver.

Send today for bulletin.

Cuts Fuel Costs

National Regulator Co.

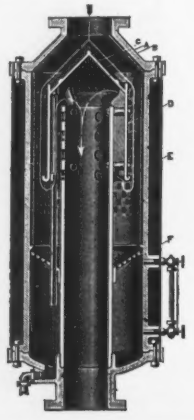
208-212 S. Jefferson St., Chicago, Illinois

Protect Your Valves and Pistons

Even a small quantity of water in the steam in your engines will break either the valve, cylinder head or piston—sometimes all three. But there is a way to remove that water.

SWEET'S Steam Separator

delivers steam to the engine 99.8% dry, without losing a single pound of pressure. Your engine is sure to give better service, your coal bill will be cut down with a Sweet's Steam Separator.



Write today for our free catalogue.

The Direct Separator Company

Also Makers of Good Exhaust Heads and Flanged Fittings

820 Geddes Street
Syracuse, N. Y.

Let the Vigilant Control Your Boiler Feed-Water and Be Safe

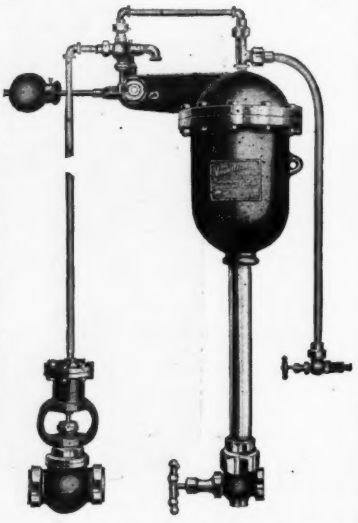
It keeps the water level always at or near the center gauge. It does this automatically, constantly, and gives you immunity from loss or serious accident resulting from boiler explosion.

But that's not all. By maintaining the water at a fixed point, it increases steaming capacity to a point that represents an added efficiency in fuel amounting to from 6 to 15 per cent.

There's nothing experimental about the Vigilant. For 20 years it has been a favorite Feed-Water regulator in the largest mills and plants in America.

Sent on 60 days' free trial.

Write us.

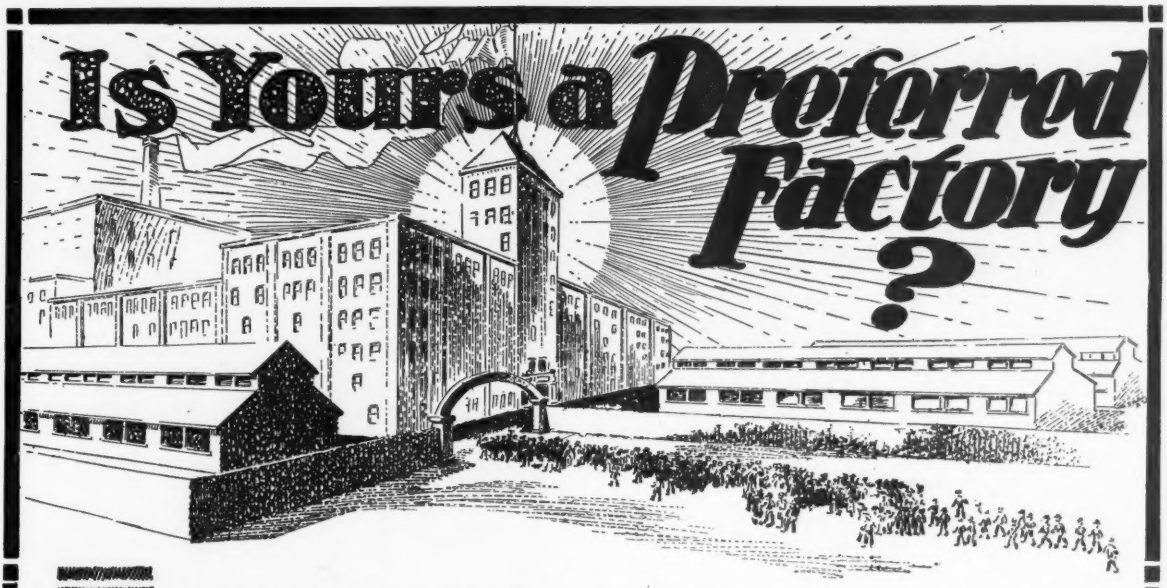


The Chaplin-Fulton Mfg. Co.

42 Penn Ave., Pittsburgh, Pa.

Also Manufacturers of the Fulton Pump Governor

Is Yours a Preferred Factory?



WHEN manufacturers are bending every effort toward increased production the first requirement is a Preferred Factory. You can put *yours* in this class. You can attract desirable workmen by so equipping your factory that they can work with greatest satisfaction to themselves.

The "worth keeping" workman has an interest in his work and output. He is not satisfied with anything less than the highest standard. Material spoiled or destroyed through inefficient *methods* or *machinery* affects the *morale* of the conscientious workman, lowers the standard of your product, reduces profits and puts a disastrous brake on production.

You can make yours a Preferred Factory—preferred by the worth-while workman who will help to make your output PREFERRED PRODUCT.

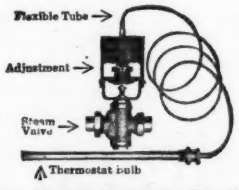
The Powers Automatic Heat Regulators

Powers Heat Regulation—applicable to practically every industrial process—automatically controls air or liquid temperatures, allowing high priced workmen to devote undivided attention to that work which requires their skill and concentrated thought. With Powers Regulation they *know* the glue pot or the dye kettle or the hot water tank cannot get too cold, nor the dry kiln or varnish room or drying room too hot.

Free the minds of your men from heat control worries; increase production; standardize your product—make yours a

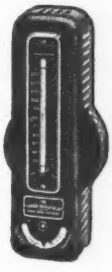
PREFERRED FACTORY

We have been making heat regulators for over thirty years. Write us about your factory and we will give you the benefit of our knowledge and experience without charge. It's our contribution toward making Factories Preferred and thus speeding up production.



The Powers Regulator No. 11

Specially adapted for the control of liquid temperatures as in hot water tanks, acid baths, glue pots, dye kettles, etc. Entirely automatic and self-contained requiring no outside power for operation. Send for Bulletin 129. Other designs for other uses wherever heat control is desirable.



How Automatic Temperature Regulation Makes Yours a PREFERRED FACTORY

An overheated office or shop makes sluggish workers, impairs their health, reduces production, increases accidents, lowers the standard of your output.

The Powers System of Temperature Regulation is easily installed in old or new buildings, costs practically nothing for upkeep, operates automatically, maintains the desired temperature, is accurate and reliable. Thirty years of actual service sustains these statements.

Powers regulation will promote pep and satisfaction among your workers, and put your factory in the Preferred Class.

The Powers Regulator Co.

Specialists in Automatic Heat Control

989 Architects Bldg., New York 2769 Greenview Ave., Chicago 390 The Federal St. Bldg., Boston

(1260) The Canadian Powers Regulator Co., Ltd., Toronto, Ont.

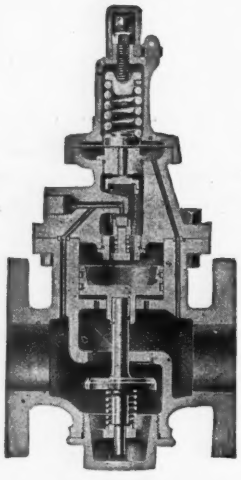
FOSTER
ENGINEERING CO.

Main Office and Factory, NEWARK, N. J.

712 Harrison Bldg.
Philadelphia, Pa.

1614 E. 40th St.
Cleveland, O.

FOSTER "Class G" PRESSURE REGULATOR

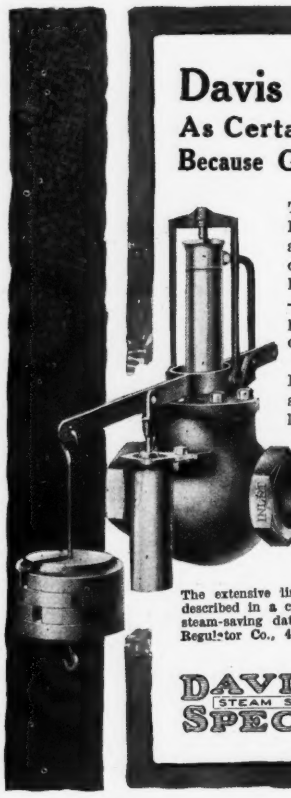


for severe and exacting service requiring close regulation, particularly for intermittent work. Suitable for working pressure up to 250 pounds. Unlimited range on terminal side, from zero to within a small percentage of the initial pressure. It will operate in any position—upright, inverted or inclined at an angle.

Write for Bulletin 40G.

AGENCIES:

Walworth Mfg. Co.....Boston-Chicago-Seattle
Geo. G. Semans & Son.....Pittsburgh, Pa.
Hiram Rivitz Co.....Cleveland, Ohio
F. W. Hay & Co.....Kansas City, Mo.
Hanks-Price Co.....Minneapolis, Minn.
The National Supply Co.....Toledo, Ohio
Sachleben & Co.....St. Louis, Mo.
Grant Whittlesey.....Ellicott Square, Buffalo, N. Y.
W. R. Ladewig.....Central Bldg., Los Angeles, Cal.
Woodward, Wight & Co.....New Orleans, La.



Davis Regulator
As Certain As Gravity Because Gravity Controlled

The Davis Pressure Regulator is positive in action because gravity controlled by weighted lever arm—no packing—no springs nor diaphragm to get out of order.

It reduces high pressure steam to the exact lower pressure at which auxiliary apparatus gives greatest efficiency and economy. Supplies uniform pressure regardless of fluctuations in boiler pressure.

The extensive line of Davis steam savers is described in a catalog chuck full of valuable steam-saving data. Write the G. M. Davis Regulator Co., 429 Milwaukee Ave., Chicago.

DAVIS VALVE
STEAM SAVERS SINCE 1875
SPECIALTIES

CONTINUOUS FEED CONTROL STETS

Steadiness

is the ideal toward which all mechanical endeavor is made. The fly-wheel on the engine and the dampers on the furnace are to eliminate fluctuations.

Stets

Boiler Feed Water Control gives a steadiness that steadies the whole plant. More even firing. More even power.

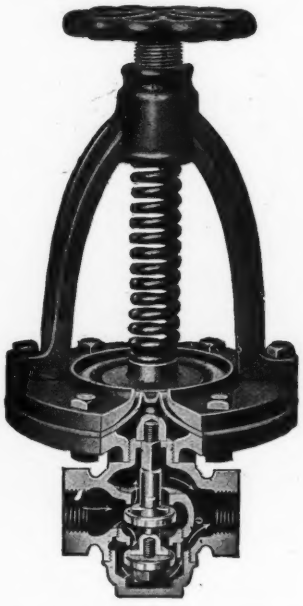
Write today for booklet on "Stets Boiler Feed Controller" the scientific steadying device of the power plant.

The Williams Gauge Company

643-5-7 Fourth Avenue Pittsburgh, Pa.

In the building of Curtis Engineering specialties the best materials and workmanship to be had have been utilized, which is one reason for their superiority and for the high standards they have set. They are constructed to give the most enduring and yet satisfying service. The

CURTIS ENGINEERING SPECIALTIES



Curtis Water Pressure Regulator

delivers water uniformly and permanently into the pipes at any pressure desired. The fluctuations of outside pressure have no effect upon it.

Rust and clogging by sediment is prevented. Wear and tear on packings and seats in valves and faucets is eliminated by the reduced pressure, which in turn reduces plumbing and repair bills. Used extensively in paper mills, hotels, public buildings and dwelling houses.

For ¾ in. to 2½ in. pipe screwed. For 3 in. to 8 in. pipe flanged.

Write for literature and learn more about the other Curtis line of engineering specialties. Fully described in our catalogue.

JULIAN D'ESTE COMPANY

26 Canal Street, Boston, 14, Mass.

83 Barclay Street
New York City

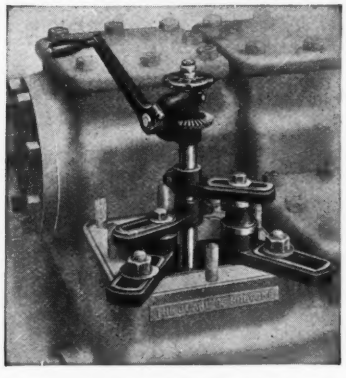
174 N. Market Street
Chicago

Reducing Fuel Costs

Fuel prices have risen, are rising, and are likely to rise still further in the future, for costs of mining, of hauling and handling are increasing steadily, and our most easily mined sources are being rapidly depleted.

It is up to the engineer who is responsible for the manufacture and utilizing of power, to keep down the fuel cost by reducing waste of power.

A sure way to stop a big power waste is to reface your pump valve seats with a



Dexter Pump Valve Reseating Machine

It is a well-known fact that the pump is the most wasteful of power plant units. This machine will reduce the slippage from 25 to 50% down to 1.8%, thus greatly reducing the fuel cost of pumping. Can you afford to be without one? Write now for Catalog T-22

The Leavitt Machine Company, Orange, Mass., U. S. A.

"Will One of My Men Fit in That Job?"

John L. Smith—Vice President and General Manager, realized that he was "up against it." His plant had reached the stage where, with the increasing cost of fuel and the necessity for more efficient management, it was necessary to put a man on the job who understood fuel and plant management.

Where to Get the Man?

Smith knew that it would have a much better effect on his men if a man for this important job could be picked from the ranks. He decided, therefore, to check over carefully each and every man in the plant. There was Jennings, who had been in the employ of the company for the last 12 years, as an engineer, a fine man in every respect, but as Smith put it, "He will never do, because he has never done any studying or reading which would fit him for an executive position of this kind." Then there was Walden, who for the last 9 years had been down in the fire room. There was the same situation—nice man, always on the job, and a good worker, but only capable of doing the same work that he had been doing since he entered the employ of the company. "It's too bad," said Smith to himself, "that these men do not see the opportunity that they have in a plant like this, or any other plant, and that they do not take advantage of it by preparing themselves for the bigger job."

One man after another was carefully checked over, but there were always several qualifications missing which would enable them to handle this important position of manager in the plant.

Smith's situation is a common one, which is constantly coming up in the average industrial organization. There are always more good jobs than there are men to fill them, due to the fact that most men become self-satisfied with their present work, get into a rut, and never get out. They are not willing to use their spare time to help them advance.

How We Can Help You

Up to within a few years ago, the average boiler room operative had little if any opportunity to step ahead. The Hays School, through the co-operation of men like Hays, Myers, Abbott, Moultrop, Rice, Parr, Harrington, Low, etc, has prepared a short cut whereby you can obtain a thorough knowledge of combustion in your spare time over the short period of 12 months, through the easy reading, and complete course in Combustion Engineering and Boiler Room Management.

Here is that once-in-a-lifetime opportunity for you to fit yourself for the position which Mr. Smith in his plant had to go outside of the plant to fill. With the fuel situation as it is today, combustion engineers in every plant are rapidly becoming a necessity. The home study course in the Hays School, has been prepared along University lines.

Hundreds of men in some of the biggest industries in the country have already blazed the way for you by enrolling for the Course. Among the plants where many students have been enrolled, are the Commonwealth Edison Co. of Chicago, Jones & Laughlin Co. at Pittsburgh, Utah-Idaho Sugar Co., Nebraska Power Co., Stone & Webster Co., Goodrich Tire Co., and others. These men, in many instances, upon recommendation of their employer, have enrolled in the Course because it is the surest and safest way to step into a position of responsibility and increased income.

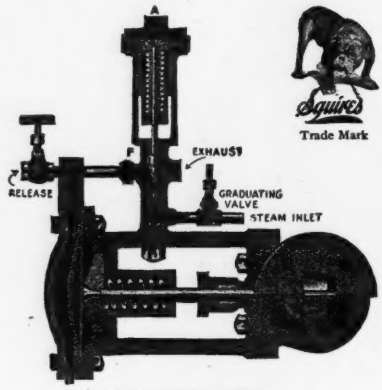
"Opportunities for the Combustion Expert" Free

A very interesting and instructive booklet outlining the features of the Course, and giving you some helpful suggestions as well, will be sent you without obligation, upon receipt of the coupon below.

HAYS SCHOOL OF COMBUSTION
Dept. 29A, 1412-1414 So. Michigan Ave., Chicago
Send "Opportunities for the Combustion Expert" free.

Name.....
Street Address.....
City..... *State*.....
Firm..... *Position*.....

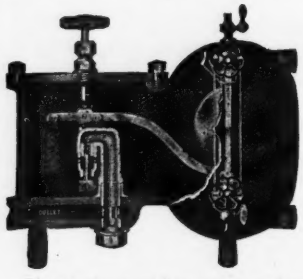
The Squires Reducing Valve



Write for Catalog E-11

The C. E. Squires Company
East 40th St. and Kelley Ave.
Cleveland, Ohio

Save Steam, Time and Trouble With Sterling Separating Traps



Simply loosen four nuts and out comes every working part of the Sterling without taking the trap out of the line.

Sterling Traps are pre-eminently get-at-able. All you have to do to dismantle one of them is remove the four top nuts and the binding nut at the bottom—take off the head and the entire valve and float mechanism comes out quickly and easily in one hand. This is one of the points that always wins repeat orders wherever Sterling Traps are once installed.

Then there's the vertical valve of Government gunmetal with its specially designed seat—arranged so that it can be reversed when one seat is worn. That's a feature that makes for long-lived efficiency.

The ball is sturdily made and is counterbalanced to insure quick action.

There are many other features in both STERLING Steam Traps and STERLING Direct Return Traps you should know about. Write today.

Templeton Manufacturing Company
Cor. Glenwood Ave. and Business St., Hyde Park, Mass.

The Mason 220-page Catalogue is the first step toward Mason Service. Copy free.

Prudent Men Avoid Risks

whenever possible to do so. When the hazard is one that involves the safety of their plant and its workers they reject it without hesitation.

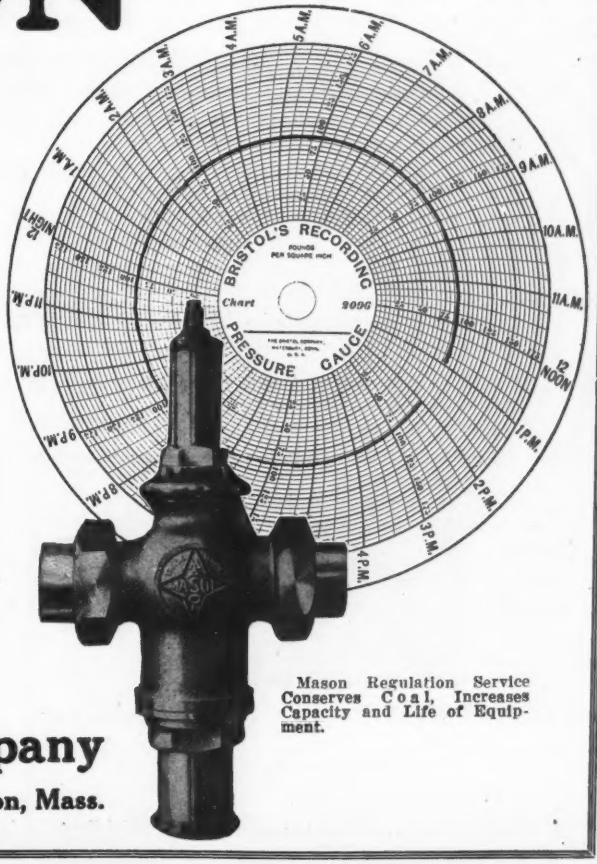
That indicates the highest possible type of sound business sense and morality.

In the power plants operated by such men the regulation of pressures is never entrusted to man. Such regulation is uncertain—frequently dangerous.

MASON REDUCING VALVES

will instead be found controlling the pressures on air, steam or water. They do it automatically, scientifically and **dependably.** They have no lapses of memory. Their attention never flags or is distracted. Their attention is ever on their task, to the end that steadiness of operation may be assured while coal, time and labor are saved.

Dealers in all large centers carry Mason Valves in stock, or they may be obtained from us direct. Write for Catalog.



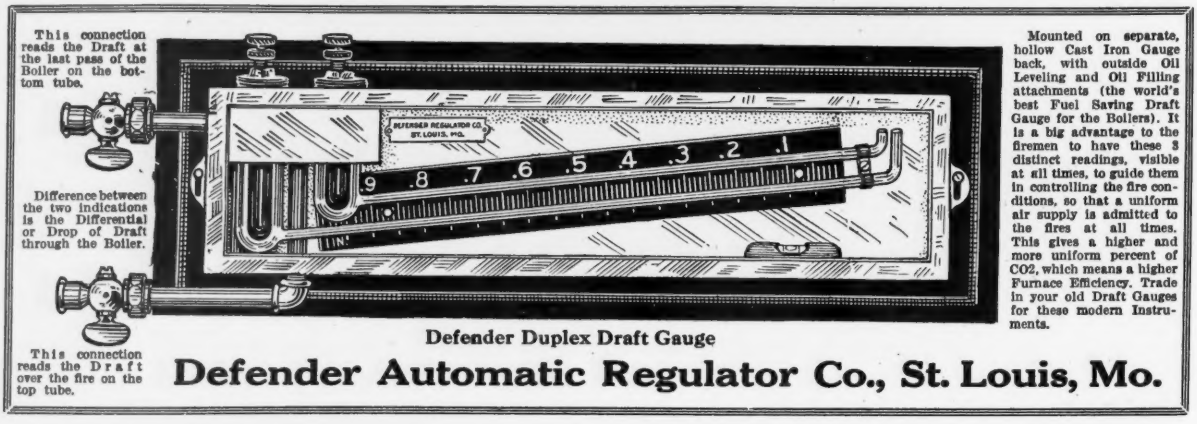
Mason Regulation Service Conserves Coal, Increases Capacity and Life of Equipment.

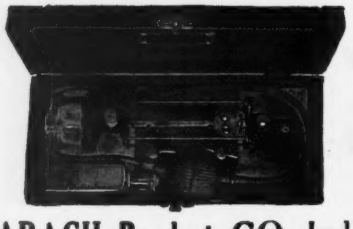
Mason Regulator Company

Dorchester Center **Boston, Mass.**

UEHLING
CO_2
Recording
Equipment
CO_2 Recorder for office of Chief Engineer Can be placed any distance from the boilers and it will trace continuous records of the changes in CO_2 exactly as they occur during every second of boiler operation
Is Saving Fuel for
Number of Uehling CO_2 Recorders
Anaconda Copper Mining Co.....30
Corn Products Refining Co.....54
Detroit Edison Co.....53
E. I. du Pont de Nemours & Co.....16
Thos. A. Edison Laboratories.....9
Ford Motor Co.....17
Southern California Edison Co.....60
Standard Oil Co.....51
U. S. Rubber Company.....25
If it can save fuel for these and scores of other leading companies, it can save fuel for you.
Uehling CO_2 Equipment reduces waste of fuel up the chimney by insuring correct air supply. It guides the fireman in burning any kind of fuel, while simultaneously recording results in the engineer's office. It usually pays for itself in a few months, or even weeks, by savings effected. Send for Bulletin 111.
CO_2 Indicator is as important to combustion economy as the water gauge glass is to safety. Mounted on the boiler front, it guides the fireman by showing the percentage of CO_2 and giving warning when improper furnace conditions prevail
UEHLING
Instrument Company
COMBUSTION ENGINEERS
2007 Empire Bldg. New York

There's a
Tycos
or
Taylor
temperature
instrument
for every
purpose
Taylor Instrument Companies


This connection reads the Draft at the last pass of the Boiler on the bottom tube.
Difference between the two indications is the Differential or Drop of Draft through the Boiler.
This connection reads the Draft over the fire on the top tube.
DEFENDER REGULATOR CO. ST. LOUIS, MO.
.9 .8 .7 .6 .5 .4 .3 .2 .1
Mounted on separate, hollow Cast Iron Gauge back, with outside Oil Leveling and Oil Filling attachments (the world's best Fuel Saving Draft Gauge for the Boilers). It is a big advantage to the firemen to have these 8 distinct readings, visible at all times, to guide them in controlling the fire conditions, so that a uniform air supply is admitted to the fires at all times. This gives a higher and more uniform percent of CO2, which means a higher Furnace Efficiency. Trade in your old Draft Gauges for these modern Instruments.
Defender Duplex Draft Gauge
Defender Automatic Regulator Co., St. Louis, Mo.


Compact and Rugged
Operates in Three Minutes
BACHARACH Pocket CO_2 Indicator
gives a reliable indication of the percentage of CO_2 in the flue gases. The higher this percentage, the more efficiently your coal is burning. Use the Bacharach Indicator to regulate your drafts and you can get almost perfect combustion. Think what a coal saving this will mean! Write today for information.
Bacharach Industrial Instrument Co. Commercial Bldg. Pittsburgh, Pa.

$105 for $100. We allow $105 for a $100 Liberty Bond when given in exchange for a Trill Indicator
The present low market value of Liberty Bonds, the 5 per cent premium offer, and the superior quality of Trill workmanship makes this an exceptional offer. If you are holding a $100 or $50 Liberty Bond, and are looking for an opportunity to invest it, here is the opportunity that no ambitious engineer can afford to overlook.
Many engineers write us of their 10 and 20 per cent salary increase due to the saving in fuel effected by tuning up their engines with the Trill. One engineer writes that he has caused a saving of 7,000 lbs. of coal per day. Another reports 4 tons saved per day, and an increase of 25 per cent in salary.
If you have no Liberty Bond write for our easy payment proposition, which places the Trill within the reach of every engineer.
TRILL INDICATOR CO.
Pine St., Corry, Pa.
No. 57

FOXBORO

STANDARD INSTRUMENTS

Recording Gauges	Thermometers
Indicating Gauges	CO_2 Recorders
Time Recorders	Psychrometers
Draft Gauges	Pyrometers
Planimeters	Temperature
Liquid Level Gauges	Controllers
Orifice Meters	

$500,000,000!

THAT is the enormous sum which, according to Enoch Burton Gowin, "annually is the waste represented by our smoking factory chimneys."

Do you know what your share of this waste is? Do you know why all these good dollars go to waste? Don't you think you ought to investigate the conditions in your plant?

FOXBORO TRADE MARK

RECORDING THERMOMETERS

will give you just the kind of information which will help you to control your coal consumption and increase the efficiency of your plant; you can maintain high and uniform Feed Water Temperature, and save Heat Units by keeping Fuel Gas Temperature down below 500 degrees Fahr.

They are adapted for any operation where an accurate knowledge of temperature is vital.

They will stand up and function correctly under the most adverse conditions.

Our new Folder D-124 is of interest to you. Send for it.

THE FOXBORO CO., Inc.

FOXBORO, MASS., U. S. A.

New York Chicago Pittsburgh San Francisco
Birmingham St. Louis Philadelphia
Tulsa Montreal

"COLUMBIA" RECORDING GAUGES

This, gentlemen, is the "Columbia" chart. We make it as distinctive in appearance as possible because it is your guarantee for absolutely accurate records of Pressure, Vacuum and Draft. That's why we designed the original "day and night" border.

Our line of "Columbia" Recording Gauges covers every modern industrial requirement from the measurement of very low draft to the measurement of the highest hydraulic pressures.

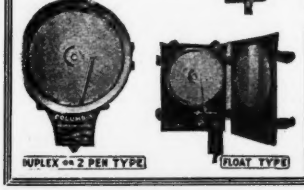
And our "Columbia" Recorder is designed and built with a thorough understanding of industrial requirements. Accurate always, sensitive, sturdy and equipped with innumerable features that are positively exclusive.

Get our Catalog, Section B100.

Schaeffer & Budenberg Manufacturing Co.

Brooklyn, N. Y.

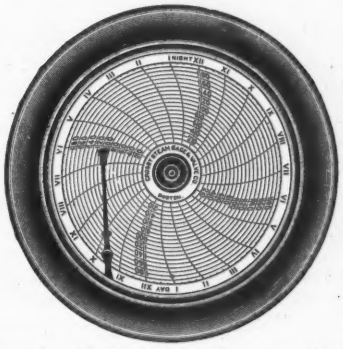
Chicago Los Angeles
Pittsburgh Philadelphia
St. Louis Washington



ALSO—Gauges for all Pressures, Vacuum and Draft. Thermometers, Tachometers, Counters, Calorimeters, Etc.

CROSBY

The Pressure Recorder with Jeweled Clock Movement



A very sensitive and durable instrument for recording variations of pressure in a steam boiler.

The movement is enclosed in dust-proof case, pressure tube, has solderless points, linkage for easy adjustment, and pen and pen table work in conjunction—all independent of the case—mounted on a socket extending to the boiler.

Chart rotates once in 24 hours. Practically no limit to range of pressure to be recorded.

Address our nearest store. It is located for your convenience.

Works at Boston, Mass.

TRADE MARK CROSBY

Crosby Steam Gage & Valve Company

New York Chicago San Francisco
London

Do You Realize What a Complete Knowledge of all These Things Means to You?

You are familiar with certain parts of power plant operation. Perhaps you do not need any advice on the handling of certain types of boilers and engines when things are running smoothly—but when the inevitable happens, a break-down, or when new equipment is being installed—or when you have occasion to change your position—

Will *You* Be Ready?

On Approval

No Money Down

$2 Per Month

Will you know how to lay a boiler or engine foundation? Can you accurately figure the horsepower of boilers and do you thoroughly understand the care and management of boilers, renewing tubes, etc.? Have you a working knowledge of combustion and proper firing, heating feed-water? Can you figure heating surface? How about draft and chimneys?

Is your knowledge of shafting and belting complete?

Are you familiar with line shafting, with the governors of the different types of engines?

How about piping? Can you connect a boiler to a steam main? Do you know the difference between iron and steel piping? Can you estimate stock?

Pumps? Can you set up, operate, set the valves, figure the horsepower and make repairs on centrifugal, duplex and boiler-feed pumps?

Can you set the valves on all types of engines? Have you a thorough knowledge of valve gears, exhaust valves, slide valves, etc.?

Will you be ready for the examiner on next examination day? Will you merely pass, or are you preparing to step up a notch? How much additional knowledge would you require to procure a first-class certificate?

If you don't know POWER CATECHISM, Volume No. 2, will tell you.

Are there more than fifteen hundred questions about electricity on your mind? We think not. Shepardson's Electrical Catechism answers that many questions in plain English. You can't fail to understand every answer.

Steam Turbines? Do you understand the Curtis, the Allis-Chalmers and other types of turbines? Would you like a complete working knowledge of all operating details connected with turbines and auxiliaries?

How are you in mathematics? Have you ever seen a book on mathematics which did not require a teacher? Palmer's book, containing about 650 pages, is one that doesn't. Would you like to brush up on common mathematics, and then step right into algebra, geometry, trigonometry, and logarithms, without any of the tortures usually connected with the conquering of these branches of mathematics?

FREE—

The greatest fuel economy book ever published

For a limited time only we are offering free to each purchaser of the Power Plant Library, Maujer & Bromley's Fuel Economy in Boiler Rooms, price $3. If after receiving the Power Plant Library, you find the books entirely satisfactory, send us your first payment of $2, when we will send you postpaid and free of all charge, the above mentioned book, written by Power editors. It is one of the most important books in America today, because it gives specific methods of saving fuel. A knowledge of fuel economy today can mean only one thing to you—increased earnings.

You can be ready—fill out this Coupon today.

FREE EXAMINATION COUPON

McGraw-Hill Book Co., Inc., 239 W. 39th St., New York.

Gentlemen: Ship the Power Plant Library, eight volumes, for my inspection. If satisfactory after examination, I will send you $2 in ten days, when you are to send me free Maujer & Bromley's Fuel Economy in Boiler Rooms. The balance I agree to remit at the rate of $2 per month until I have paid the price of the books, $16. If not satisfactory, I will write for shipping instructions.

Signature .....

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City and State .....

Name of Employer .....

Occupation PPE-12-15-20

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239 West 39th Street **New York**

THE HOT-FLOW

The International HOT-FLOW Softener delivers water for boilers that can form no scale.

Besides being heated, the water is uniformly softened—the non-scaling hardness remains constantly at 1½ to 2 grains.

Uniform results are only possible with Hot-Flow construction, which provides sedimentation that takes care of slight temperature changes and the convection currents.

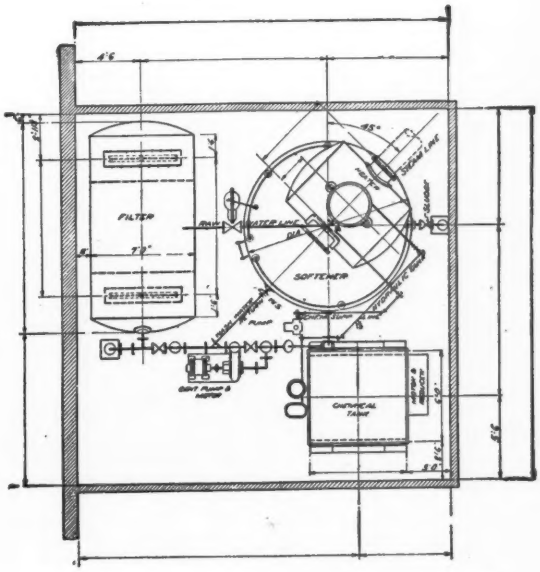
Another exclusive advantage: the filter is properly washed with hot water that is not wasted, but returned and saved.

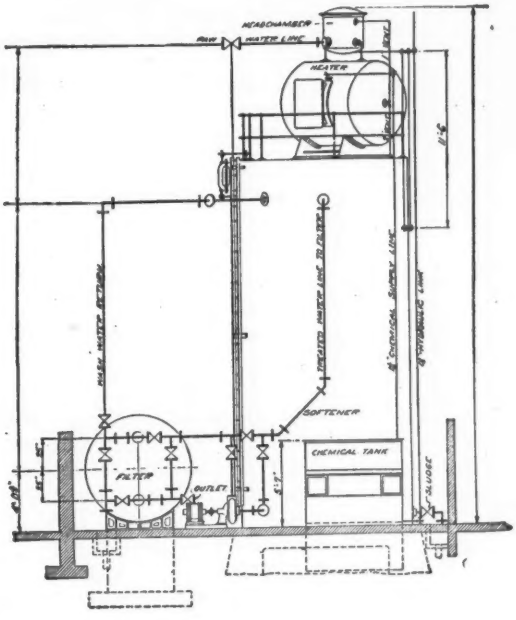
There are other advantages found only in the Hot-Flow; write for Bulletin P. E. 63.

20 years' experience
in water purification

INTERNATIONAL FILTER CO.

General Offices:
First National Bank Building, Chicago, Ill.





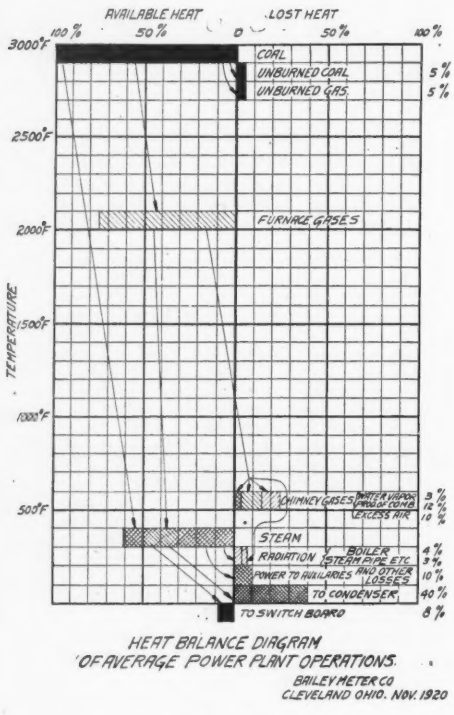
To the Right:

The Hot-Flow Layout for Station "A" Pacific Gas and Electric Company, San Francisco, Calif.

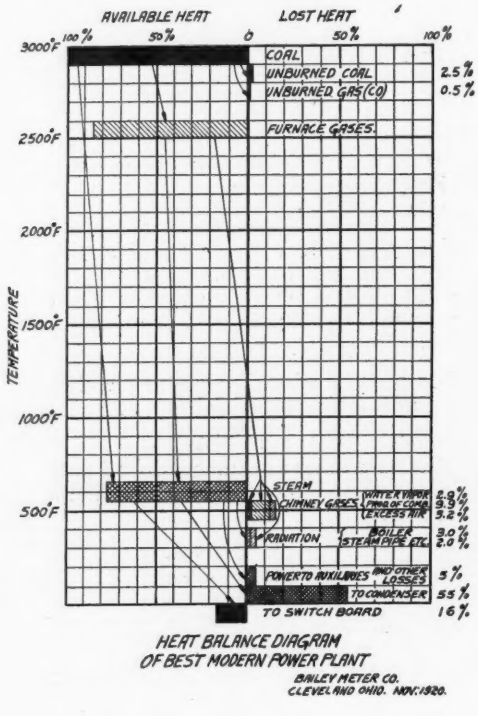
Capacity: 16,380 gallons per hour make-up water for Boiler-Feed.

There is greater need for fuel conservation now than there was during the War. The Hot-Flow is in line with this movement.

Which Diagram Represents Your Plant?



HEAT BALANCE DIAGRAM
OF AVERAGE POWER PLANT OPERATIONS.
BAILEY METER CO
CLEVELAND OHIO. NOV. 1920



HEAT BALANCE DIAGRAM
OF BEST MODERN POWER PLANT
BAILEY METER CO.
CLEVELAND OHIO. NOV. 1920.

DO you know enough about your plant to make a diagram of the heat distribution on this Temperature B.t.u. Basis?

Every B.t.u. that enters the furnace in the form of coal goes some place. It complies with the law of "The Conservation of Energy."

In the financial department of every successful business, the auditor knows where each dollar goes. A great deal of time and money is spent in drawing up cost figures and balance sheets—and they MUST BALANCE.

Heat units cost money—they have a very real money value—and should be accounted for the same as cash in the till. Meters and instruments are ABSOLUTELY ESSENTIAL for compiling the daily heat balance of the power plant, while cash registers and calculating machines are only time-saving conveniences in making the trial balance for the Treasurer.

One dollar is just as good as another, but some B.t.u.'s are a thousand times more valuable than others. The ocean is full of heat units—billions of billions of them—but they are worthless for the generation of power because they are at such a low temperature or potential.

The above Heat Balance Diagrams are laid out on a temperature basis to show that certain losses in the power plant mean a great deal more than do others. For instance, unburned coal or gas are high potential losses, capable of producing high furnace temperatures—high pressure steam—and really doing things; while the heat to the condenser—the biggest loss in the plant—is at a temperature of about 100 degrees F.—and, therefore, useless for the generation of power.

The Flue Gas loss is also large and at a high potential and should be checked accurately and continuously. It is invisible and elusive, so that meters are required to record it continuously.

More Heat Balance Dope In the Next Issue

In succeeding copies of Power Plant Engineering we will describe some of these losses in more detail and illustrate same by means of 12-inch chart records from meters, reproduced full size in original colors. As these chart records are larger than the pages of Power Plant Engineering, the Postoffice will not permit their being included as advertisements, so we will mail them direct to any reader of Power Plant Engineering who will send his name on coupon. Get your name in promptly so you will get the first chart with January 1st issue of Power Plant Engineering.

COUPON FOR FREE CHART

Bailey Meter Company, 2013 East 46th St., Cleveland, Ohio.

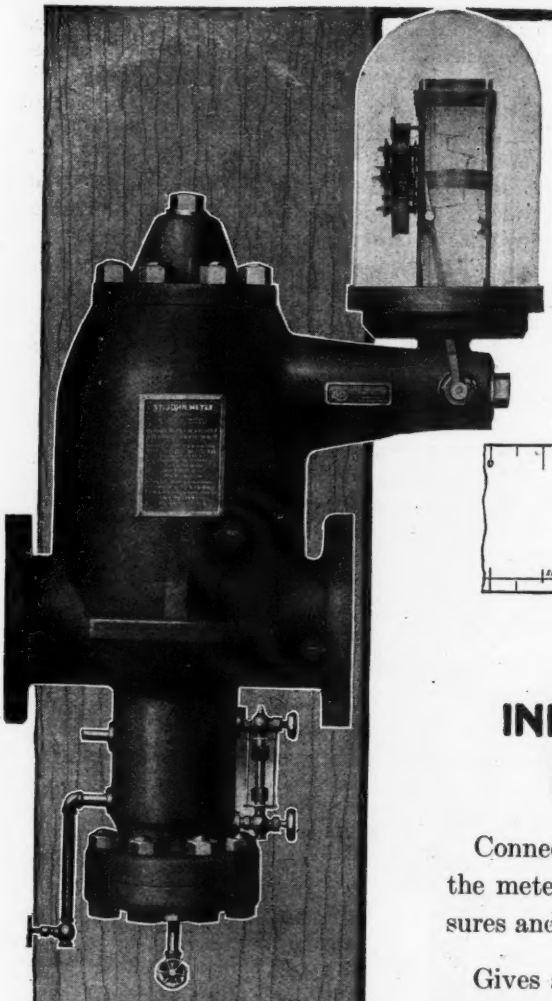
Please send chart records from meters supplementing your ads in Power Plant Engineering beginning with January 1st issue.

Name .....

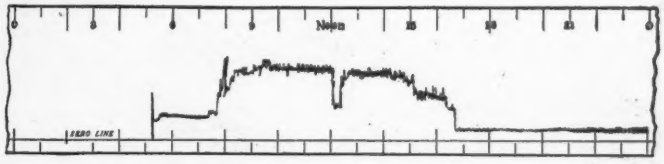
Street .....

City ..... State.....

Bailey Meter Co., 2013 E. 46th St., Cleveland, Ohio



MEASURE the *steam* you use as accurately as you now measure water, gas and electricity.



ST. JOHN
INDICATING & RECORDING
STEAM METER

Connects in steam line. All steam passes **through** the meter. Measures all steam flowing at all pressures and under varying loads.

Gives a graphical, minute-by-minute record, on a ribbon of metallic chart paper, of the exact amount of steam used during any period of time—guaranteed accurate to within 2 per cent.

You cannot know your costs unless you can determine the exact quantity of steam used in the operation of your engines, pumps, blowers, drying rooms, or for other purposes.

Write for Bulletin 146-PP and Full Information

AMERICAN DISTRICT STEAM COMPANY

General Office and Works:
North Tonawanda, N. Y.

Branches:

First Nat'l Bank Bldg. Chicago. — Eastern Representatives, Barclay Sales & Engineering Co., 1777 Woolworth Bldg., New York — Hoge Bldg., Seattle.

ADSCO

ESTABLISHED 1849

THE SCHMIT TRUNK COMPANY

MANUFACTURERS OF

WARDROBE, DRESS AND STEAMER TRUNKS

OSHKOSH, WISCONSIN, U. S. A.

February 12, 1920.

Yarnell-Waring & Co.,

Chicago, Ill.

Gentlemen: Attention Mr. J. C. Veling

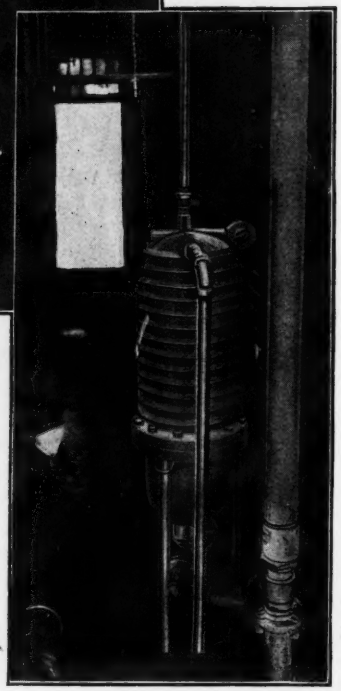
In reply to your request as to the result of our experience with your Automatic Boiler Cleaner which we purchased from you some time ago, we are very gratified at the results and do not see how we managed to get along as well as we did without it.

We have had no occasion to use any boiler compound since this boiler cleaner was installed. Formerly we found it necessary to clean our boilers every two weeks and found considerable scale. Since we put in this boiler cleaner, we only clean boilers about once in two months and find practically no scale.

Yours very truly,

THE SCHMIT TRUNK CO.

HRI/AJ BY H. R. Imm Secretary.



Yarway Boiler Skimmer installed in the boiler room of The Schmit Trunk Company, at Oshkosh, Wis.

Photostat of their original letter shown above.

Have you ever counted up how much it costs to clean a boiler?

Not only does it frequently cost several hundred dollars to remove the deposits of scale and sediment, but every shut-down of a boiler piles up other costs and each successive deposit of scale or sediment hastens the depreciation of the boiler, increases its maintenance and decreases its *safe* efficiency.

The installation of a

YARWAY

BOILER SKIMMER

A continuous circulating surface-blow

removes scale-forming impurities and foreign matter from the boiler feed water before they can settle on the tubes and shell.

If you have not seen it, write for Bulletin 1201-A that describes this boiler safeguard.

YARNALL-WARING CO.

Penna. R. R. and Mermaid Lane, Chestnut Hill

PHILADELPHIA

YARWAY

POWER PLANT PRODUCTS

are being used in thousands of plants. They are sold under a money-back guarantee.

OFFICES IN PRINCIPAL CITIES

For complete list of offices, see Sweet's Engineering Catalog, Condensed Catalogs of A. S. M. E., Sterling Marine Catalog, Keystone Mining Catalog or Chemical Catalog.

Don't "OPERATE" on Your Boilers

Why cut, gouge and mutilate the sensitive tubes? Long ago the best engineering practice discarded the knife. Today the best practice relies upon Science—**Chemical** Science. It doesn't wait until the ills of scale, corrosion and pitting have become rampant and the case is one of emergency. No! The best practice trusts to Chemical Science to **prevent** these boiler diseases and to keep the patient in the most robust health.

It's the water, of course. It may look innocent and absolutely harmless, but it usually carries the plagues of Egypt in its mineral contents. Not especially injurious while cold—on the war path for destruction when hot.

These mineral salts vary widely and each has its special sphere of destructiveness. For instance, one salt blankets the tubes with heat-repelling scale so that they cannot make steam. Much of the coal then burned is undigested and wholly wasted.

Other salts act solely for corrosion and pitting—which means to metal what rotting does to wood. Still other salts are the agents of foaming, priming, etc. These are especially dangerous and the cause of many boiler explosions.

Any or all of these dangerous elements in boiler feed can be neutralized and made impotent. But **first the water must be analyzed.** Chemical Science finds out **exactly** what mineral salts it contains and the proportion of each.

The **Dearborn Company** maintains a staff of expert chemists for this work. After the water is analyzed and the dangerous salts determined, it is a simple matter to select the correct reagents for the trouble-makers and prepare the proper formula for treatment.

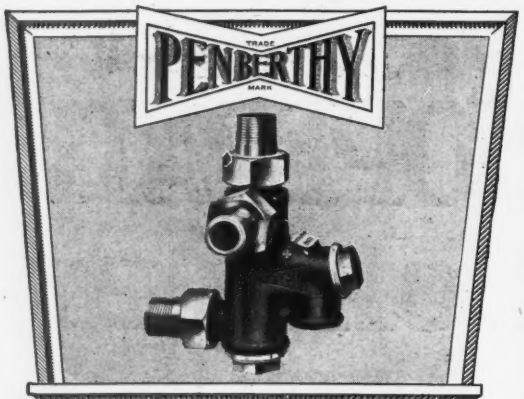
Many thousands of plants have proven the success of Dearborn Individualized Water Treatment. These plants have clean boilers all the time, operate steadily and save coal, the expense of mechanical cleaning, and the injury to tubes that often follows. Write, and we'll gladly send full information. Why not send us a gallon sample of your feed water for analysis and report?

Dearborn Chemical Company

General Offices, Laboratories and Works: Chicago.
General Eastern Offices: 299 Broadway, New York.
Branch Offices in Principal Cities.
Canadian Factory: 2454-2464 Dundas Street, Toronto, Ontario.

DEARBORN

INDIVIDUALIZED Water Treatment



The Most Famous Automatic Injector In the World

THIS Penberthy Automatic Injector is used in every civilized country in the world. It is personally known to every engineer of importance and is used in most of the schools in America.

It is absolutely automatic. It never fails and simply as a matter of boiler room insurance is worth many times its cost.

The Penberthy Automatic Injector should be in every boiler room whether equipped with pumps or not, simply as a safeguard against breakdown.

The design is the same today as it has been for 33 years—the most successful Injector ever made.

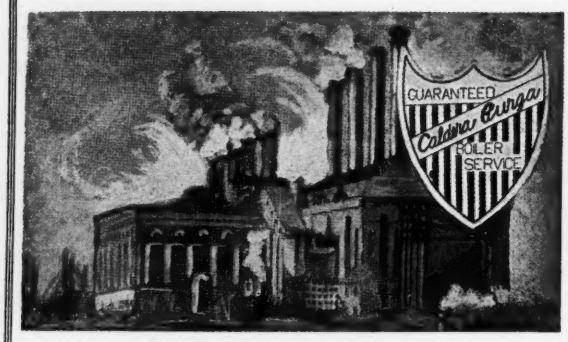
The Penberthy Trade Mark is on every genuine Penberthy Automatic Injector. Look for it.

Interesting new catalogue of boiler room specialties sent free on request. Address Dept. "S."

PENBERTHY INJECTOR COMPANY

Established 1886

New York Depot 71 Beekman St. | Detroit, Mich. | Canadian Plant Windsor, Ontario



In Big, Efficient Plants

Caldera Purga

Saves Fuel, Labor and Equipment

In one large plant in St. Louis, Caldera Purga Turbine Cleaner showed increased efficiency of its turbines from 50% to 90% after use.

It cleaned the lime and foreign deposits from nozzles, blades, glands and buckets, allowing the turbines to operate at highest efficiency.

Containing no harmful ingredients, such as caustic or acid, it will not corrode delicate parts of turbine. Keeps valves clean and preserves them.

Lubricator type of feed used to feed direct to turbine through main steam line.

A sixty (60) day demonstration given to prove worth of goods. Money refunded if results are not satisfactory.

Full particulars and instructions for use upon request.

Caldera Purga Company, Inc.

947 Peoples Gas Bldg. Chicago, Ill.

Why You Should Install a Buckeye Boiler Skimmer

It prevents scale formation.
It prevents mud accumulation.
It saves fuel.
It reduces repair bills.
It is low in first cost.
It costs nothing to maintain.
It lasts as long as the boiler.
It is sent on 30 days' trial.

Write for our new book "Prevention of Scale Formation" — It's Free.

BUCKEYE BOILER SKIMMER CO.

Water Works Drive Toledo, Ohio

Eastern Representative
W. F. Cremean, 316 Miners Bank Bldg., Wilkes-Barre, Pa.

Western Representative
C. J. Holland, 730 Peoples Gas Bldg., Chicago, Ill.

The Boiler Metal Treatment

The Modern Method of Boiler Scale Removal and Prevention

Removes Scale by Mechanical Expansion

See me "Expand" in next issue

Perolin Co. of America

New York Chicago
St. Louis Toledo

Here's Your Opportunity

to buy good used equipment at prices that will make it well worth your while. Look through the Signboard Section carefully. Then if you don't find just what you want, advertise for it. Among the thousands of plants into which Power Plant Engineering goes the equipment you want may be lying idle right now. Whenever you are in need use the

SIGNBOARD SECTION

WATER
Softeners & Filters

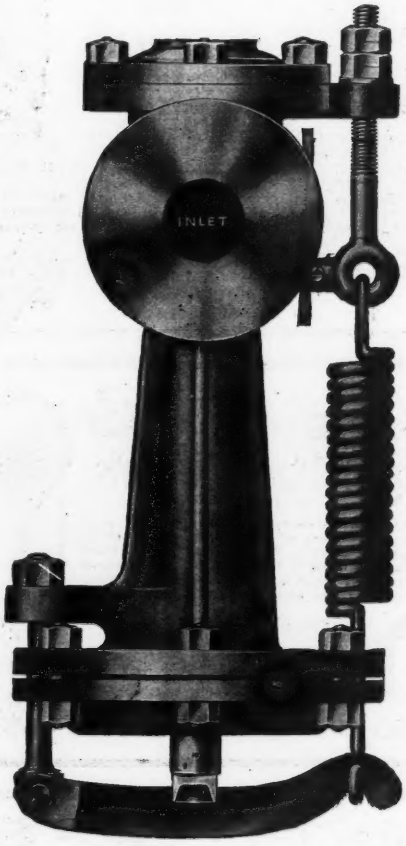
Iron and Oil Removal Apparatus—Filtration Equipment—Water Conditioning Apparatus of every description

The Permutit Company

440 Fourth Ave. New York

AULD "QUITETITE" Reducing Valves

for Dependable, Uniform, Pressure Reducing Service



"Auld" reducing valves have been on the market for over sixty years and "Quitetite" is the most recent development of our long progressive experience.

Auld "Quitetite" Reducing Valves are specially designed to reduce pressure and to hold the lower pressure constant irrespective of fluctuations in boiler pressure and varying demand for low-pressure steam.

"Quitetite" has no sleeves or stuffing boxes to cause friction or irregular operation. It is a single "dead tight" valve simply constructed to occupy very little space. The flexible diaphragm protected by a water column is made of durable rubber composition and eliminates the danger of sudden bursting common to bronze, steel or other metal types.

The valve and seat can be reground or refaced without the inconvenience of uncoupling the piping and as these valves last for years without attention, upkeep and repairs are negligible.

Large numbers of "Quitetite" valves are in use supplying reduced pressure for heating, boiling, dyeing, etc., in almost every industry. It's the valve for your plant.

Write for Catalog

Schutte & Koerting Co.

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New York 50 Church Street
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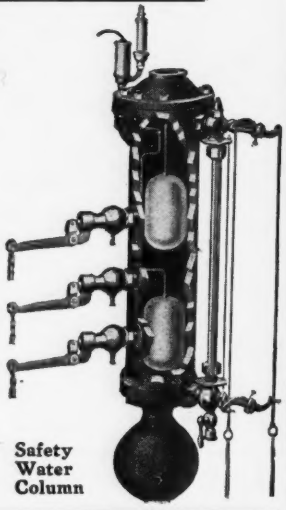
Pittsburgh 933 Oliver Building

Chicago: A. C. Nell, Agent, 730 Lumber Exchange Building
New Orleans: Southern Jobbers Supply Co. Agent, 534 Bienville Street
Atlanta: Wm. J. Neville, Agent, 1522 Chandler Building
Charlotte: I. Hardeman, Agent, Realty Building

Reliance Steam Specialties

Specify
Reliance
Safety Water Column
Electric Water Alarm
Quick Closing Water Gauge
Monel Disc Gauge Cock
Seamless Copper Floats
Steam Trap
WRITE


Safety Water Column

RELIANCE GAUGE COLUMN CO.
5932 Carnegie Ave. CLEVELAND, O.

ROTO TUBE CLEANERS

for
Reduced Fuel Bills

THE ROTO COMPANY
Hartford, Conn.
Write for Catalogue

"Results Are More than Expected"
wrote the Dayton Lumber & Mfg. Co. when sending in a repeat order for
National Girth Seam Protectors
This means something nowadays when so much is expected. A set of these protectors will eliminate all leaks and fire cracks from your boilers and work a continuous saving on your repair bills.

The National Boiler Protector Co.
740-741 Reibold Bldg.,
Dayton, Ohio,
U. S. A.

Standard in the World's Largest Power Plants

Every boiler needs a mechanical soot blower. Leaders of world industry, such as General Electric, Ford Motor, Du Pont Powder, Standard Oil, have found Diamond design and construction superior. If your boilers are not equipped, write for Bulletin 210.

DIAMOND POWER SPECIALTY COMPANY
Detroit, Michigan
Diamond
SOOT BLOWERS - SAVE 4 to 8% FUEL

VULCAN
Soot Cleaners
are essentials nowadays in every boiler plant where some attempt is being made to reduce fuel consumption and cut operating costs.

Write for free Bulletin describing the Vulcan Cleaner for YOUR boilers and ask us to tell you how it will return 50 to 100 percent on the investment. (Mention type of boilers).

VULCAN SOOT CLEANER CO.
25 So. Brady St. DU BOIS, PA.

Easy to Operate

Shears Out the Soot

Ruggles Perfection Flue Cleaner
with quick, flexible, easy motion digs out the soot and leaves the fire tubes clean. Self-adjusting, it acts directly on the tubes, overriding all imperfections, welds, and blisters.
Satisfaction guaranteed. Order from your dealer or direct. Write today for our bulletin.
RUGGLES & RUGGLES, Batavia, Illinois

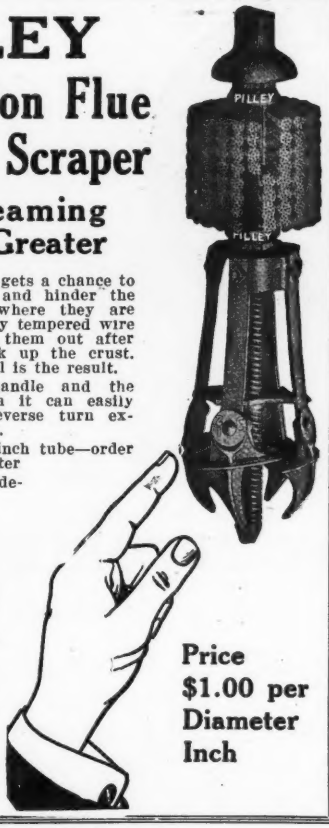
PILLEY
Combination Flue Brush and Scraper
Makes Steaming Capacity Greater

No scale or soot ever gets a chance to clog the boiler tubes and hinder the production of steam where they are kept in use. The highly tempered wire of the brushes cleans them out after the scraper ends break up the crust. More heat with less fuel is the result.

Simply turn the handle and the scraper contracts, then it can easily enter the tube. A reverse turn expands it to fit the tube.

Sizes for 2-inch to 6-inch tube—order by outside tube diameter

Catalog with fuller details sent on request.

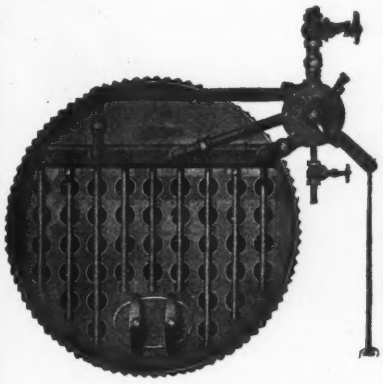


Pilley Packing and Flue Brush Mfg. Co.

611 S. Third Street
St. Louis, Mo.

Eastern Office: 71 Fulton St., New York

Price $1.00 per Diameter Inch



Force the Soot Out

"Soot is one of the most efficient insulating materials known."—Joseph Harrington, formerly Administrative Engineer for State of Illinois. (P. 394, Power Plant Engineering, May 1, 1919.)

Harrington knows — so does every other engineer. The

National Flue Cleaner

is a series of pipes on the boiler front, that simply forces all soot and ash before it.

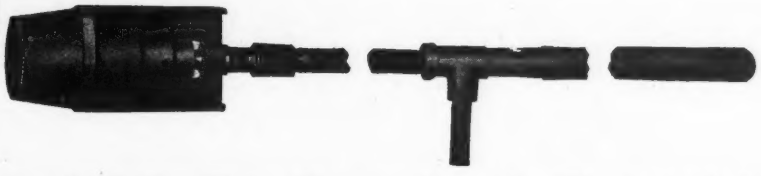
Steam is projected with great force from the jets of each section, scouring out soot and ash. A second or so cleans the entire boiler.

Saves labor and coal. Increases boiler capacity. An indestructible system, requires no repairs and maintenance cost slight. **Results guaranteed.** Write for particulars and testimonials.

In order that we can name you price, please state number of tubes in each of your return tubular boilers, also state whether uptake is front or rear.

National Flue Cleaner Company, Inc.
GROVEVILLE, N. J.

A Real Fuel Saver



Sent on Trial

The Tornado Boiler Tube Cleaner Does the Work with Dry Air

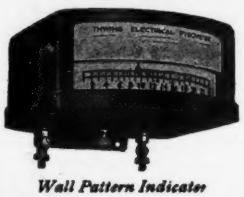
by using just enough steam through ½-inch hose to secure a strong, continuous blast. More efficient and economical than scraper or brush.

The Paul B. Huyette Co., Inc. Suite 3, No. 5 South 18th Street **Philadelphia, Pa.**

THWING PYROMETERS

are furnished with Recording or Indicating Galvanometers of the type most suitable for power plant use. Dust, moisture and fume proof. Not affected by vibration, yet sufficiently sensitive to record electromotive force of a thermocouple.

Calibrated to read directly in degrees of heat, Thwing Galvanometers have a resistance of over 800 ohms when used on a full range scale with base-metal thermocouples.



Wall Pattern Indicator

Ask for our engineering advice.

Thwing Instrument Co.
3344 Lancaster Avenue
PHILADELPHIA

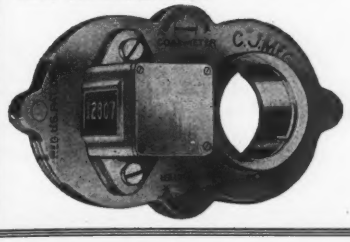
Never Guess About Coal

Know exactly how much is burned under each boiler and what is accomplished.

C. J. COAL METERS

give the absolute facts about your coal and an indisputable record of boiler performance. They spur firemen to better and more economical work.

Our circular tells the story. Write for copy.



C. J. Mfg. Company
3427 North 5th Street
Philadelphia, Pa.

Scale is too expensive a luxury for *your* plant

OR FOR ANY OTHER PLANT for that matter. And as long as the scale remains on the tubes a great deal of good coal is being wasted daily in forcing heat through these walls of heat resisting material.

The cost of a pound of boiler scale on the tubes is exceedingly high. Conversely the value of a Lagonda Boiler Tube Cleaner in your plant can be estimated by the number of pounds of scale it takes out of the boilers, or, in other words, by the amount of fuel saved by removing this scale.

No matter whether or not you are treating your water to remove scale forming impurities, you still need Lagonda Cleaners to complete the work; to run through the tubes at every inspection period, thus making sure that scale is entirely removed and all tubes in good condition.

Get busy with a Lagonda Cleaner

522

The Lagonda Mfg. Co.
SPRINGFIELD, OHIO.
FUEL SAVING SPECIALISTS
NEW YORK, CHICAGO, PHILADELPHIA, BOSTON, PITTSBURG, CLEVELAND CINCINNATI, DETROIT SYRACUSE, ST LOUIS, KANSAS CITY, DENVER, DALLAS, SAN FRANCISCO, MONTREAL, LONDON

Boiler Tube Cleaners
Condenser Cleaners
Boiler Tube Cutters
Boiler Cap and Header
Reseating Machines
Cleaner Feeding Device for Curved Tube Boilers
Automatic Cut-Off Valves
Grease Extractors

Sparks from the Advertising Pages

Where Buyers and Sellers Meet

"Drive Thy Business, Let Not That Drive Thee"

When the universe was wound up and myriads of worlds set whirling through infinite space, it would seem that it was likewise inexorably decreed that all creation should move and fulfill its cycle of existence.

"The world do move" is an expression of the people which means that no created thing can stand still.

Look into an ant hill and you will find these busy insects driving their business, even as the greatest corporation must drive its business if it would survive.

Only man, out of all created things, has the power to choose his way through life, to determine in a measure the orbit of his cycle of existence and to organize, shape and build his business enterprises according to his ideals.

But even man cannot stand still, for he who standeth still is left behind, while all creation is moving onward.

The crucial test of men and of business is here. World-wide restlessness, which always denotes a new era of world-wide progress, is passing from the period of a vast waste of human energy in strikes and agitation to the harnessing of that human energy to a newer and greater driving force.

With this greater human power must be coupled a greater mechanical power. Human progress demands advance in tools and machines, in methods and materials.

None but the most shortsighted can for a moment entertain hopes of going back to prewar conditions. A great forward movement is under way, and the immediate need is for coordination of its forces to the smooth-running hum of a mightier industry than was ever experienced in this world before.

Next to man-power, now ready and anxious to settle down to business, the great, basic driving force of horsepower must be rebuilt, overhauled and prepared to develop more power and that more economically and efficiently.

Capital is in control today—finance that has had the last vestige of frenzy beaten out of it.

Capital will look only for efficiency. The biggest enterprise in the world could not get capital today for carrying on business along the lines of war or pre-war times. "Millions for basic economy, but not one cent for waste" is the motto of capital now.

Power plant men who will advance, or who can even hope to survive, must know the ways and means to re-create their plants to a standard of efficiency that is set for the next twenty years—not the last twenty.

For the men who sincerely and earnestly are working ahead, POWER PLANT ENGINEERING is published.

In its advertising pages are represented the equipment, machinery and supplies that are required in the plants that shall survive and share in the greater prosperity for those prepared to accept it.

Back of the products advertised here are progressive business organizations that are driving their business and not letting their business drive them.

These firms advertise because they are driving their business most economically. They advertise because they can give the service you need to drive your business and therefore their products will bear advertising.

Drivers of business look to business drivers for the help they need. Winners run with winners. Only those who are about to fall by the wayside will tarry with those who loiter while the procession moves onward.

Machinery, Equipment and Supplies Used In The Production and Transmission of Power

Under the heading of each product listed will be found the names of the manufacturers of that product. The index to advertisers, next to the back cover, gives the page numbers on which the manufacturers' descriptive advertisements appear.

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Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Steam Pump Co., Battle Creek, Mich.
American Well Works, The, Aurora, Ill.
Chicago Pneumatic Tool Co., N.Y.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
De Laval Steam Turbine Co., Trenton, N. J.
Gardner Governor Co., Quincy, Ill.
Ingersoll-Rand Co., New York.
Nordberg Mfg. Co., Milwaukee.
Worthington Pump & Machinery Corp., New York, N. Y.
Yeomans Bros. Co., Chicago, Ill.

AIR RECEIVERS AND AFTER COOLERS.
Chicago Pneumatic Tool Co., N.Y.

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Budd Grate Co., Philadelphia.
Detrick Co., M. H., Chicago.
Girtanner Eng'r'g Co., New York
Green Engineering Co., East Chicago, Ind.
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Detrick Co., M. H., Chicago.
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Girtanner Eng'r'g Co., New York
Green Engineering Co., East Chicago, Ind.
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Link-Belt Company, Chicago.

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National Tube Co., Pittsburgh.

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Jeffrey Mfg. Co., Columbus, O.
Portable Machinery Co., Inc., Passaic, N. J.

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Graton & Knight Mfg. Co., Worcester, Mass.
Ladew Co., Inc., Edw. R., Glen Cove, N. Y.
New York Belting & Packing Co., New York, N. Y.
Quaker City Rubber Co., Phila.
Pioneer Rubber Mills, San Francisco, Cal.
Rossendale-Reddaway Belting & Hose Co., New York, N. Y.
Schieren Co., Chas. A., N. Y.
Voorhees Rubber Mfg. Co., Jersey City, N. J.

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Marion Mach. Fdry. & Supply Co., Marion, Ind.
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BOILER CLEANER—METAL.
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BOILER COMPOUND.
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National Boiler Protector Co., Dayton, Ohio.

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Budd Grate Co., Philadelphia.
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Jointless Fire Brick Co., Chicago.
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Ladd Co., Geo. T., Pittsburgh.
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Budd Grate Co., Philadelphia.

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Reading Valve & Fittings Co., Reading, Pa.

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Girtanner Engin'r'g Corp., N. Y.
Godfrey Conveyor Co., Elkhart, Ind.
Green Engineering Co., East Chicago, Ind.
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Link-Belt Company, Chicago.
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Elliott Company, Jeannette, Pa.
Griscom-Russell Co., New York.
Ingersoll-Rand Co., New York.
Manistee Iron Works, Manistee, Mich.
Ross Heater & Mfg. Co., Buffalo.
Schutte & Koerting Co., Phila.
Wheeler Cond. & Eng'r'g Co., Carteret, N. J.
Wheeler Mfg. Co., C. H., Phila.
Worthington Pump & Machinery Corp., New York, N. Y.

CONDUIT FOR UNDERGROUND HEATING PIPES.
Ric-Wil Co., Cleveland, Ohio.

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Barber-Greene Co., Aurora, Ill.
Beaumont Co., R. H., Phila., Pa.
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Detrick Co., M. H., Chicago.
Gifford-Wood Co., Hudson, N. Y.
Girtanner Eng'r'g Co., New York
Godfrey Conveyor Co., Elkhart, Ind.
Green Engineering Co., East Chicago, Ind.

MADDOCK POTTERY Trenton, N. J.

Cling-Surface Co., Buffalo, N. Y.
This photograph shows a 26", 2-ply leather belt, 13 years old, on 8' pulleys, 25 ft. centers, speed 2140 ft. per minute and running 48" slack. The load here at times goes up to 150 H. P. Putting the theoretical capacity of this belt as 130 H. P., the overload reaches nearly 15 per cent, but the chief engineer, H. H. Yates, says, "This belt never slips, but as peak load comes on simply sags further down on the pulleys." Every belt in this pottery is run slack with Cling-Surface.

There is no Slipping Here

Picking up by its trunk logs weighing hundreds of pounds the elephant carries and piles them with utmost ease.

Why doesn't the log slip from the trunk?

Cohesion prevents it doing so. As a boy you've probably played with a wet leather sucker and picked up stones with it. How it did grip!

That was cohesion—the perfect contact of two surfaces. That's the elephant's way.

Cling-Surface

imparts this gripping power to belts. Lubricates every tiny fibre, so that the belts become pliable—with the clinging quality of a moist human hand.

There is then perfect contact between belt and pulley face. This permits running the belts slack, because they cannot slip. The slacker the belts run the more pulley face they wrap and the more power they transmit.

Tight belts are short-lived and soon lose their natural elasticity. Tension ruins them.

Tight belts eat up power. They cause bearings to grind—destructive to bearings and a drain on power. Tight belts slip—more power lost. They have no cohesion.

The Elephant's way is the best

Cling-Surface imparts to belts the elephant's grip. Prove it on your own belts and pay if O. K. **Cling-Surface** comes in 25 and 50-lb. cans, the 50-lb. being a little cheaper. Send in the coupon.

Cling-Surface Company, 1028 Niagara Street, BUFFALO, N. Y.

Warehouse Stocks in a Dozen Cities

Savac—the Cable Saver
Your costly wire ropes and cables are soon ruined by rust. They're worth protecting. Lubricate them with SAVAC. This will penetrate to every strand and keep them rust proof. Cables gain years of life. We make SAVAC and guarantee its work. Write for SAVAC booklet.

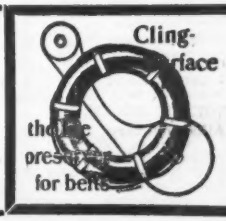
MAIL THIS COUPON

Cling-Surface Co., 1028 Niagara St., Buffalo, N. Y.
Gentlemen: Please send me items herewith checked:

[] Cling-Surface Booklet 5.
[] 25-lb. Can Cling-Surface.
[] 50-lb. Can Cling-Surface.
[] Place my name on your mailing list.
[] Tell us about Savac.

Name .....

Address .....PPE—12-15-20



Jeffrey Mfg. Co., Columbus, O.
Link-Belt Company, Chicago.
Roots, P. H. & F. M. Co., Connersville, Ind.
Portable Machinery Co., Inc., Passaic, N. J.

COOLERS, OIL.

Griscom-Russell Co., New York.

COOLING SYSTEMS.

Badger & Sons Co., E. B., Boston
Spray Eng'r'g Co., Boston, Mass.
Star Brass Works, Chicago, Ill.
Wheeler Cond. & Eng'r'g Co., Carteret, N. J.
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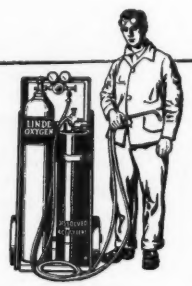

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Jenkins Bros., New York, N. Y.
Hollow Center Packing Co., Cleveland, Ohio.
Imperial Packing Co., New York.
Johns-Manville, Inc., N. Y.
Johns-Pratt Co., Hartford, Conn.
New York Belting & Packing Co., New York, N. Y.
Pilley Pkg. & Flue Brush Mfg. Co., St. Louis, Mo.
Pioneer Rubber Mills, San Francisco, Cal.
Powell Co., The Wm., Cincinnati.
Quaker City Rubber Co., Phila.
Robertson & Sons, Jas. L., N.Y.
Strong Mach. & Supply Co., N. Y.
Voorhees Rubber Mfg. Co., Jersey City, N. J.

PACKING, VALVE STEM.
N. Y. Belting & Pkg. Co., N. Y.

PAINT, HEATED SURFACE.
Ric-Wil Co., Cleveland, Ohio.

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American Pipe Bending Mach. Co., Boston, Mass.
Badger & Sons Co., E. B., Boston
Crane Co., Chicago, Ill.
National Pipe Bending Co., New Haven, Conn.
Pittsburgh Piping & Equipment Co., Pittsburgh, Pa.
Power Piping Co., Pittsburgh.

PIPE CLAMPS.
Yarnall-Waring Co., Phila., Pa.

PIPE-CLEANERS.
Acme Oil Works, Philadelphia.

PIPE COILS.
Badger & Sons Co., E. B., Boston
National Pipe Bending Co., New Haven, Conn.

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Johns-Manville, Inc., N. Y.
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Ric-Wil Co., Cleveland, Ohio.

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Mark Mfg. Co., Evanston, Ill.

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Borden Co., The, Warren, Ohio.
Curtis & Curtis Co., Bridgeport, Conn.
Mark Mfg. Co., Evanston, Ill.

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American District Steam Co., Tonawanda, N. Y.

PIPING.
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National Tube Co., Pittsburgh.
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Pittsburgh Piping & Equipment Co., Pittsburgh, Pa.
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Foxboro Co., Foxboro, Mass.
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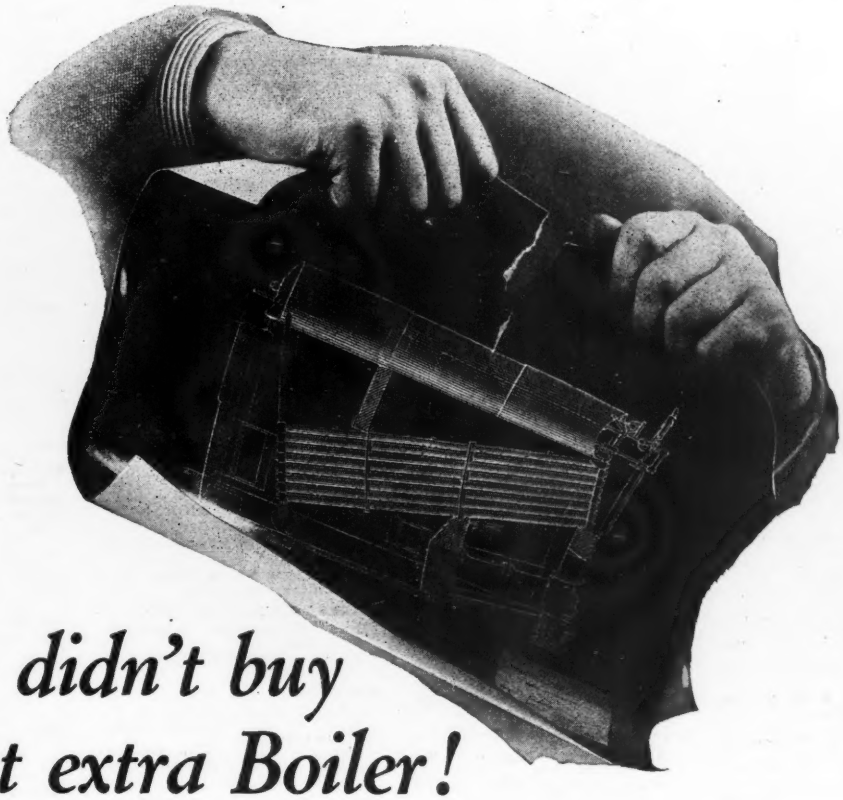

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Mr. Steam user, have you overhauled your plant lately? Isn't it more than possible you are *wasting tons of coal* every day by insufficient covering? "85% Magnesia" is the best possible coal saver, but you need *enough* of it to get the *maximum* of coal saving at the higher pressures you are using today.

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Don't buy an extra boiler before you write us, and be sure to read "Defend Your Steam," the new treatise on coal saving, full of valuable information, tables and data. It is sent free to plant executives on request.

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Croll-Reynolds Co., Inc., N. Y.
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Moore Steam Turbine Corp., Wellsville, N. Y.
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Manistee Iron Works, Manistee, Mich.
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American Steam Pump Co., Battle Creek, Mich.
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Huyette Co., The Paul B., Phila.
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National Regulator Co., Chicago.
Powers Regulator Co., Chicago.
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Squires Co., The C. E., Cleveland, Ohio.
Williams Gauge Co., Pittsburgh.
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Powers Regulator Co., Chicago.
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Taylor Instrument Cos., Rochester, N. Y.

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Leavitt Machine Co., Orange, Mass.
Schiller, Jos. F., Philadelphia.

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d'Este Co., Julian, Boston, Mass.
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National Pipe Bending Co., New Haven, Conn.
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Pittsburgh Valve, Foundry & Const. Co., Pittsburgh, Pa.
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Voorhees Rubber Mfg. Co., Jersey City, N. J.
Waterbury Co., New York, N. Y.

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Yarnall-Waring Co., Phila., Pa.

STEAM TRAPS.
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Armstrong Machine Wks., Three Rivers, Mich.
Crane Co., Chicago, Ill.
Davis Regulator Co., G. M., Chicago, Ill.
d'Este Co., Julian, Boston, Mass.
Elliott Company, Jeannette, Pa.
Ellis Drier Co., The, Chicago.
Illinois Engineering Co., Chicago.
Johns-Manville, Inc., N. Y.
Nashua Machine Co., Nashua, N. H.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Patterson-Kelley Co., The, N.Y.
Powers Regulator Co., Chicago.
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Sarco Company, Inc., New York.
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Squires Co., The C. E., Cleveland.
Templeton Mfg. Co., Hyde Park, Mass.
Watson & McDaniel Co., Phila.
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Williams Valve Co., D. T., Cincinnati, Ohio.

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General Electric Co., Schenectady, N. Y.
Kerr Turbine Co., Wellsville, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.
Terry Steam Turbine Co., Hartford, Conn.
Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.

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Underfeed Stoker Co. of America, Detroit, Mich.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.

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National Carbon Co., New York.

STRAINERS.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
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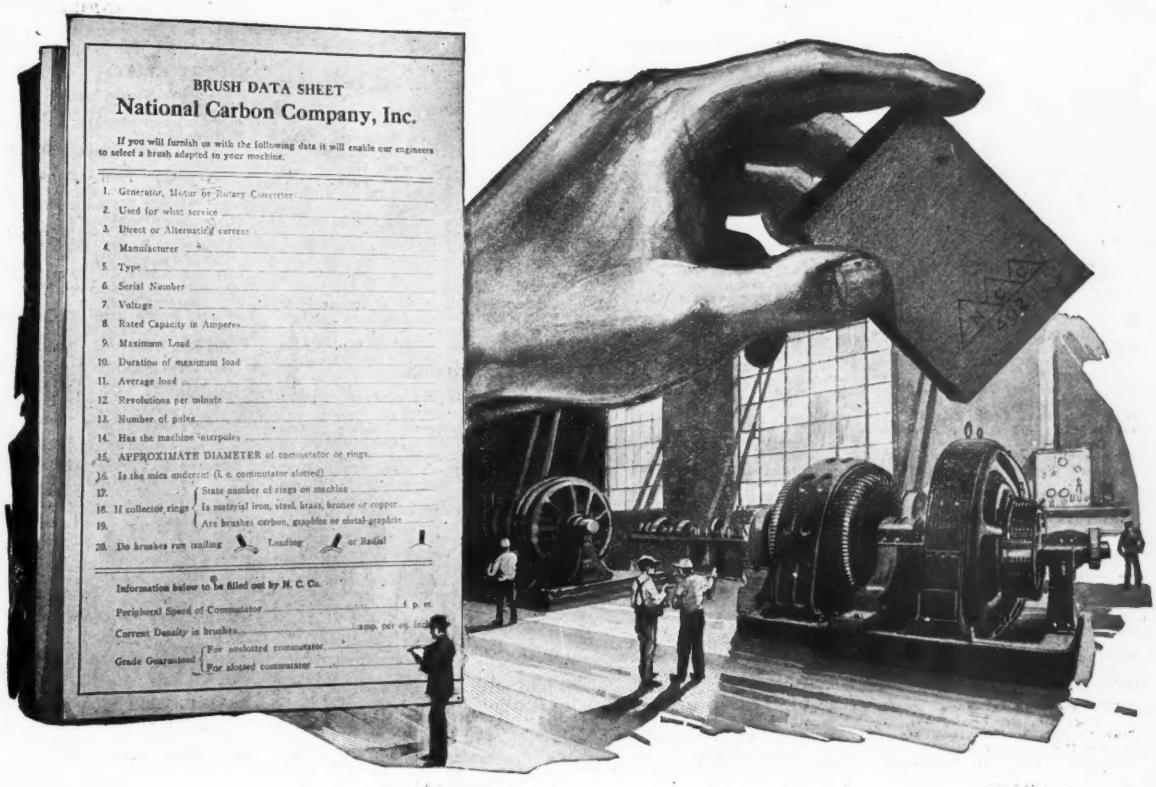
BRUSH DATA SHEET
National Carbon Company, Inc.
If you will furnish us with the following data it will enable our engineers to select a brush adapted to your machine.
1. Generator, Motor or Rotary Converter
2. Used for what service
3. Direct or Alternating current
4. Manufacturer
5. Type
6. Serial Number
7. Voltage
8. Rated Capacity in Amperes
9. Maximum Load
10. Duration of maximum load
11. Average load
12. Revolutions per minute
13. Number of poles
14. Has the machine interpoles
15. APPROXIMATE DIAMETER of commutator or rings
16. Is the mica undercut (i. e. commutator slotted)
17.
18. If collector rings
19.
State number of rings on machine
Is material iron, steel, brass, bronze or copper
Are brushes carbon, graphite or metal-graphite
20. Do brushes run trailing Leading or Radial
Information below to be filled out by N. C. Co.
Peripheral Speed of Commutator f. p. m.
Current Density in brushes amp. per sq. inch
Grade Guaranteed
For unslotted commutator
For slotted commutator

Picking brushes for the job

THE Columbia Data Sheet Service will assure correct brushes for each of your motors and generators. It is a service of investigation, analysis, and specification by Columbia Brush Specialists. The Columbia Pyramid Brushes they specify are guaranteed to be satisfactory.

Avail yourself of this service; fit each machine with the brush best suited for the operating conditions. The service is at your command whether you have one unit or a thousand.

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Solves Your Brush Problems

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Lagonda Mfg. Co., Springfield, Ohio.

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Power Specialty Co., New York.

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TANKS.

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Heine Safety Boiler Co., St.Louis.
Lancaster Iron Works, Inc., Lancaster, Pa.
Scaife & Sons Co., Wm. B., Pittsburgh, Pa.
Sims Co., The, Erie, Pa.
Springfield Boiler Co., Springfield, Ill.
Wayne Oil Tank & Pump Co., Fort Wayne, Ind.

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National Regulator Co., Chicago.
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Taylor Instrument Cos., Rochester, N. Y.
Thwing Instrument Co., Phila.

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Strong Mach. & Supply Co., N.Y.
Williams & Co., J. H., New York.

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Ellis Drier Co., The, Chicago.
Farnsworth Co., Conshohocken, Pa.
Illinois Engineering Co., Chicago.
Nashua Machine Co., Nashua, N. H.
Sarco Company, Inc., New York.
Schutte & Koerting Co., Phila.
Templeton Mfg. Co., Hyde Park, Mass.

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Liberty Mfg. Co., Pittsburgh.
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Scully Steel & Iron Co., Chicago.

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Leavitt Machine Co., Orange, Mass.

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Lagonda Mfg. Co., Springfield, Ohio.
Ruggles-Klingemann Mfg. Co., Salem, Mass.

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Foster Engineering Co., Newark, N. J.
Golden-Anderson Valve Spec. Co., Pittsburgh.
Kelly Controller Co., Chicago.
Nelson Valve Co., Philadelphia.
Strong, Carlisle & Hammond Co., Cleveland, Ohio.

VALVES, BALL.

Locomotive Superheater Co., N.Y.
Williams Valve Co., D. T., Cincinnati, Ohio.

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Hancock Inspirator Co., N. Y.
Homestead Valve Mfg. Co., Homestead, Pa.
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Lunkenheimer Co., Cincinnati, O.
Nelson Valve Co., Philadelphia.
Powell Co., Wm., Cincinnati, O.
Pratt & Cady Co., Inc., Hartford, Conn.
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Scully Steel & Iron Co., Chicago.
Williams Valve Co., D. T., Cincinnati, Ohio.
Yarnall-Waring Co., Phila., Pa.

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Jenkins Bros., New York, N. Y.
Kennedy Valve Co., Elmira, N. Y.
Mason Regulator Co., Boston.
Nelson Valve Co., Philadelphia.
Pittsburgh Valve, Foundry & Const. Co., Pittsburgh, Pa.
Powell Co., Wm., Cincinnati, O.
Pratt & Cady Co., Inc., Hartford, Conn.
Schiller, Jos. F., Philadelphia.
Scully Steel & Iron Co., Chicago.
Williams Valve Co., D. T., Cincinnati, Ohio.
Yarnall-Waring Co., Phila., Pa.

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Chapman Valve Mfg. Co., The, Indian Orchard, Mass.
Hancock Inspirator Co., N. Y.
Jenkins Bros., New York, N. Y.
Kelly Controller Co., Chicago.
Kennedy Valve Co., Elmira, N. Y.
Lonergan Co., J. E., Phila., Pa.
Lunkenheimer Co., Cincinnati, O.
Nelson Valve Co., Philadelphia.
Ohio Brass Co., Mansfield, Ohio.
Pittsburgh Valve, Foundry & Const. Co., Pittsburgh, Pa.
Pratt & Cady, Inc., Hartford, Conn.
Powell Co., Wm., Cincinnati, O.
Schutte & Koerting Co., Phila.
Strong Mach. & Supply Co., N.Y.

VALVE DISCS.

Belmont Packing & Rubber Co., Philadelphia, Pa.
Goetze Gasket & Packing Co., New Brunswick, N. J.
Jenkins Bros., New York, N. Y.
Kennedy Valve Co., Elmira, N. Y.
N. Y. Belting & Pkg. Co., N. Y.
Ohio Brass Co., Mansfield, Ohio.
Sandusky Packless Valve Co., Sandusky, Ohio.
Strong Mach. & Supply Co., N.Y.

VALVES, FLOAT.

Davis Regulator Co., G. M., Chicago, Ill.
Foster Engineering Co., Newark, N. J.
Golden-Anderson Valve Spec. Co., Pittsburgh.
Mason Regulator Co., Boston.
Ruggles-Klingemann Mfg. Co., Salem, Mass.

VALVES, GAS.

Smith Gas Eng. Co., Dayton, O.

VALVES, GATE.

Chapman Valve Mfg. Co., The, Indian Orchard, Mass.
Crane Co., Chicago, Ill.
Jenkins Bros., New York, N. Y.
Kennedy Valve Co., Elmira, N. Y.
Lunkenheimer Co., Cincinnati.
Nelson Valve Co., Philadelphia.
Ohio Brass Co., The, Mansfield, Ohio.
Pittsburgh Valve, Foundry & Const. Co., Pittsburgh, Pa.
Powell Co., Wm., Cincinnati, O.
Pratt & Cady Co., Inc., Hartford, Conn.
Schutte & Koerting Co., Phila.

VALVES, GLOBE.

Bashlin Co., The, Warren, Pa.
Crane Co., Chicago, Ill.
Golden-Anderson Valve Spec. Co., Pittsburgh.
Hancock Inspirator Co., N. Y.
Jenkins Bros., New York, N. Y.
Kennedy Valve Co., Elmira, N. Y.
Lunkenheimer Co., Cincinnati.
Nelson Valve Co., Philadelphia.
Ohio Brass Co., The, Mansfield, Ohio.
Pittsburgh Valve, Foundry & Const. Co., Pittsburgh, Pa.
Powell Co., Wm., Cincinnati, O.
Pratt & Cady Co., Inc., Hartford, Conn.
Sandusky Packless Valve Co., Sandusky, Ohio.
Schutte & Koerting Co., Phila.

VALVES, HYDRAULIC.

Chapman Valve Mfg. Co., The, Indian Orchard, Mass.
Crane Co., Chicago, Ill.
Federal Metallic Pkg. Co., Boston
Homestead Valve Mfg. Co., Homestead, Pa.
Kennedy Valve Co., Elmira, N.Y.

VALVES, PACKLESS.

Sandusky Packless Valve Co., Sandusky, Ohio.

VALVES, POP SAFETY.

American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Ashton Valve Co., Boston, Mass.
Crosby Steam Gage & Valve Co., Boston, Mass.
Foster Engineering Co., Newark, N. J.
Jenkins Bros., New York, N. Y.
Lonergan Co., J. E., Phila., Pa.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady Co., Inc., Hartford, Conn.

VALVES, PUMP.

Chapman Valve Mfg. Co., The, Indian Orchard, Mass.
New York Belting & Packing Co., New York.
Quaker City Rubber Co., Phila.
Strong Mach. & Supply Co., N. Y.
Voorhees Rubber Mfg. Co., Jersey City, N. J.

VALVES, RADIATOR.

American District Steam Co., Tonawanda, N. Y.
Ohio Brass Co., The, Mansfield, Ohio.
Powell Co., Wm., Cincinnati, O.

VALVES, REDUCING.

Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crosby Steam Gage & Valve Co., Boston, Mass.
Davis Regulator Co., G. M., Chicago, Ill.
d'Este Co., Julian, Boston, Mass.
Elliott Company, Jeannette, Pa.
Foster Engineering Co., Newark, N. J.
Golden-Anderson Valve Spec. Co., Pittsburgh, Pa.
Mason Regulator Co., Boston
National Regulator Co., Chicago
Nelson Valve Co., Philadelphia
Ohio Brass Co., The, Mansfield Ohio.
Powers Regulator Co., Chicago.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Sarco Company, Inc., New York
Squires Co., C. E., Cleveland
Watson & McDaniel Co., Phila

VALVES, REGRINDING.

Mason Regulator Co., Boston.
Penberthy Injector Co., Detroit.

VALVES, RELIEF.

American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Davis Regulator Co., G. M., Chicago, Ill.
Foster Engineering Co., Newark, N. J.
Golden-Anderson Valve Spec. Co., Pittsburgh, Pa.
H. S. B. W.-Cochrane Corp., Philadelphia, Pa.
Jenkins Bros., New York, N. Y.
Lonergan Co., J. E., Phila., Pa.
Mason Regulator Co., Boston.
Nelson Valve Co., Philadelphia.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Scott Valve Mfg. Co., Detroit.

VALVES, RUBBER.

Belmont Packing & Rubber Co., Philadelphia, Pa.
Federal Metallic Packing Co., Boston, Mass.
Lonergan Co., J. E., Phila., Pa.
N. Y. Belting & Pkg. Co., N. Y.
Quaker City Rubber Co., Phila.
Voorhees Rubber Mfg. Co., Jersey City, N. J.

VALVES, SAFETY, NON-RETURN.

Golden-Anderson Valve Spec. Co., Pittsburgh, Pa.
Kelly Controller Co., Chicago.
Lunkenheimer Co., Cincinnati.

VENTILATING APPARATUS.

Badger & Sons Co., E. B., Boston.
Burt Mfg. Co., Akron, Ohio.
Wing Mfg. Co., L. J., New York.

WASTE, COTTON AND WOOL.

Royal Mfg. Co., Rahway, N. J.

WATER COLUMNS AND ALARMS.

Anderson Co., V. D., Cleveland.
Lunkenheimer Co., Cincinnati.
Reliance Gauge Column Co., Cleveland, Ohio.
Williams Gauge Co., Pittsburgh.

WATER METERS.

Bailey Meter Co., Cleveland.
H. S. B. W.-Cochrane Corp., Philadelphia, Pa.
Hoppes Mfg. Co., Springfield, O.
Yarnall-Waring Co., Philadelphia.

WATER PURIFYING APPARATUS.

International Filter Co., Chicago.
Permutit Co., The, New York.
Scaife & Sons Co., Wm. B., Pittsburgh, Pa.

WATER SOFTENING SYSTEMS.

Dearborn Chemical Co., Chicago.
International Filter Co., Chicago.
Permutit Co., The, New York.
Scaife & Sons Co., Wm. B., Pittsburgh, Pa.

WELDING APPARATUS.

General Electric Co., Schnectady, N. Y.
Oxweld-Acetylene Co., New York.

WELDING CARBONS.

National Carbon Co., New York.

WHISTLES.

Ashton Valve Co., Boston, Mass.
Crosby Steam Gage & Valve Co., Boston, Mass.
Lonergan Co., J. E., Phila., Pa.
Powell Co., Wm., Cincinnati, O.

WIRE OF EVERY DESRIPTION.

American Steel & Wire Co., Chicago-New York.

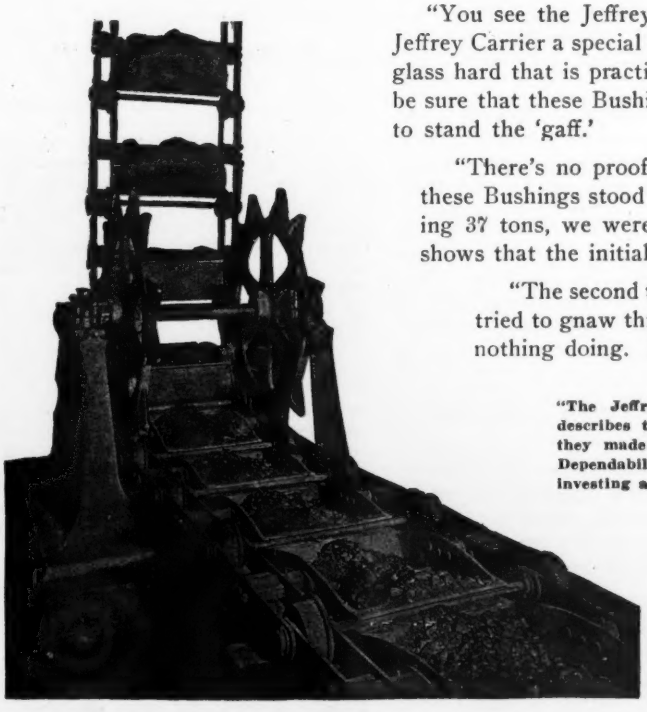
WIRE ROPE AND FITTINGS.

American Steel & Wire Co., Chicago-New York.

WRENCHES.

Armstrong Mfg. Co., Bridgeport, Conn.
Curtis & Curtis Co., Bridgeport, Conn.
Strong, Carlisle & Hammond Co., Cleveland, O.
Strong Mach. & Supply Co., N. Y.
Williams & Co., J. H., Brooklyn.

"We Jacked 37 Tons on These Jeffrey Roller Bushings Before They Distorted a Bit



"You see the Jeffrey People give the Double Bushings of the Jeffrey Carrier a special heat treatment which makes a finish almost glass hard that is practically immune to wear. But we wanted to be sure that these Bushings had the right toughness and resilience to stand the 'gaff.'

"There's no proof so convincing as a practical test. When these Bushings stood up without distortion with the gauge reading 37 tons, we were satisfied. Moreover, the ragged fracture shows that the initial toughness is preserved and increased.

"The second test was just as interesting as the first. They tried to gnaw through the outer walls with a sharp file—but nothing doing. It's almost glass hard, all right.

"The Jeffrey Co. are putting out Catalog No. 210-G, which describes the Carrier completely and tells of the practical test they made before they were satisfied with the Reliability and Dependability of this New Jeffrey Carrier. You'll never regret investing a stamp to write for it."

The Jeffrey Mfg. Company
905 North Fourth St., Columbus, O.

New York	Charleston, W. Va.	Birmingham
Boston	Chicago	Dallas
Philadelphia	Los Angeles	Milwaukee
Scranton	St. Louis	Denver
Pittsburgh	Detroit	Montreal
Cleveland		Buffalo

Handle it Mechanically

SIGNBOARD SECTION

Quick Action Opportunities

CLASSIFIED RATES

Advertisements in the Signboard Section which come under the classification "Position Wanted," "Help Wanted," "Salesmen and Agencies," "Business Opportunities," "Patent and Patent Attorneys" and "Technical Books" will be set in type as shown below and published at the rate of

50 cents a line

each insertion, 6 words to a line; minimum sold, 4 lines.

For display of any advertisement under the above classified headings see sizes and rates in column at right.

DISPLAY RATES

Advertisements in Signboard Section which come under the classifications "Equipment for Sale," "Equipment Wanted," "Educational and Instruction" and "Miscellaneous" are set in display space of the following sizes and at these rates:

1 in.	$ 5.50	4 in.	$20.80
2 in.	10.80	1 col. (8¼ in.)	43.35
3 in.	15.90	2 col. (17 in.)	85.00

Not less than one inch to be sold in these classifications.

For advertising rates under other headings in this section, see column at left.

POSITIONS WANTED

ENGINEER, 17 yrs.' experience, all phases power and industrial plant operation and maintenance, desires connection with an organization interested in obtaining maximum efficiency and reduced power costs through the application of practical engineering management. Address Box 642, Power Plant Engineering, 537 So. Dearborn St., Chicago, Ill.

GRADUATE ELECTRICAL ENGINEER, twelve years' experience in power plant operation, combustion, motor application and wiring, heating and construction of factory buildings. Can furnish best of references to progressive firm with opportunity for advancement. Address Box 643, Power Plant Engineering, 537 So. Dearborn St., Chicago, Ill.

POSITION WANTED—By engineer who thoroughly understands engine and boiler room operation and can reduce maintenance cost to the minimum. Desires to locate with 300 to 400 H.P. electric light plant. Best references. Address H. S. Betts, 2326 16th Avenue, Rockford, Illinois.

ENGINEER WANTS EMPLOYMENT—Experienced in operation, maintenance and repair of industrial plant boiler and engine rooms up to 4000 hp. capacity. Prefer chance to extend combustion efficiency experience. Can handle men. Go anywhere. Middle age. Address Box 647, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 12-1-1

POSITION WANTED—As plumber in first class power plant or hotel. Desires North Carolina as location. References can be furnished by chief engineer where presently employed. Address Box 645, Power Plant Engineering, 537 So. Dearborn St., Chicago, Ill. 11-15-1

A No. 1 Erecting and Construction Engineer, married, wants position with reliable company, with chance of advancement. Will travel; capable of taking full charge of work; 20 years' experience on Power Plant and Equipment; good executive, capable of handling men and getting results; employed at present, must give ten days' notice. Plant work preferred. State salary and expense allowance. Address Box 627, POWER PLANT ENGINEERING, 537 So. Dearborn St., Chicago, Ill. 11-15-1

POSITIONS WANTED

POSITION WANTED—As engineer in a small steam plant of 75 to 150 H.P. by ex-service man. Had over 5 years experience in small plant. Good mechanic. Former employer as reference. Open for position about Dec. 10. Write, R. Siebke, Walcott, Iowa.

HELP WANTED

WANTED—An ambitious fireman, and an assistant engineer in New York City. Single men preferred, good opportunities with room and board. Address Box 646, Power Plant Engineering, 537 So. Dearborn St., Chicago, Ill. 11-15-1

WANTED—Experienced man to take charge of and operate one shift, in a Municipal Lighting Plant. Newly equipped with Fairbanks Morse Oil Engines. State references. Address Box A, Quincy, Mich.

WANTED—A good operating engineer. Give description of past experience in first letter, also give references. Apply to W. L. Schmidt, Chief Engineer. Consolidated Light & Power Co., Kewanee, Ill.

SALESMEN AND AGENCIES

AGENTS WANTED who call on boiler plants to represent old established firm in several open desirable territories. Commission basis. Address Box 599, Power Plant Engineering, 537 So. Dearborn St., Chicago, Ill. tf

Sales engineers desired in the following cities to represent an old established firm in the sale of an apparatus of unprecedented success for power plants. Only the highest type of representative, well recommended, will be considered. Cincinnati, St. Louis, Cleveland, Little Rock, El Paso, Dallas, Houston and Jacksonville. Box 640, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf

MISCELLANEOUS

NOTICE—To users of steam boilers. Crack the scale off your boiler flues and shell by a simple method. No chemicals, no mechanical devices, no tools, no work. Ten minutes required. Send $2.00 and I will tell you how. Will also tell you how to make a very cheap compound to prevent scale forming. Twenty-six years' experience in boiler and engine rooms. Address Wm. Inman, 1408 State St., La Porte, Indiana.

PATENTS AND PATENT ATTORNEYS

PATENTS PROCURED—Trade Marks registered. A comprehensive, experienced, prompt service for the protection and development of your ideas. Preliminary advice gladly furnished without charge. Booklet of information and form for disclosing idea free on request. Richard B. Owen, 28 Owen Bldg., Washington, D. C. tf

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 622 F. St., Washington, D. C. Established 1883. I make an examination and report if a patent can be had and the exact cost. Send for full information. tf

A. P. CONNOR, Consulting Electrical and Mechanical Engineer. Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf

PATENTS

Patents obtained and Trade-Marks registered in the United States and foreign countries. Patent practice exclusively in Patent Office and Courts. Examinations made and opinions rendered as to patentability of inventions, and validity, scope and infringement of patents. Highest references. Watson E. Coleman, Patent Lawyer, 624 F Street, Washington, D. C.

SIGNBOARD SECTION
Quick Action Opportunities

TECHNICAL BOOKS

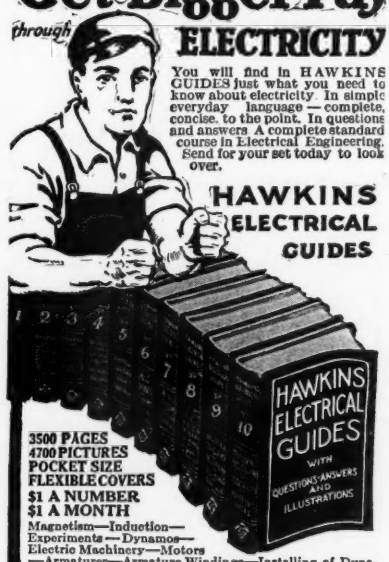
Opportunities

What Are You Looking For ?

—a position
—a man to fill a vacancy
—a business representative
—a buyer for your used equipment
—good used equipment that is for sale

You'll find them in the SIGNBOARD SECTION

Get Bigger Pay through ELECTRICITY



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3500 PAGES
4700 PICTURES
POCKET SIZE
FLEXIBLE COVERS
$1 A NUMBER
$1 A MONTH

Magnetism—Induction—Experiments—Dynamos—Electric Machinery—Motors—Armatures—Armature Windings—Installing of Dynamos—Electrical Instrument Testing—Practical Management of Dynamos and Motors—Distribution Systems—Wiring—Wiring Diagrams—Sign Flashers—Storage Batteries—Principles of Alternating Currents and Alternators—Alternating Current Motors—Transformers—Converters—Rectifiers—Alternating Current Systems—Circuit Breakers—Measuring Instruments—Switch Boards—Power Stations—Installing—Telephone—Telegraph—Wireless—Bells—Lighting—Railways. Also many modern Practical Applications of Electricity and Ready Reference Index of the 10 numbers.

Shipped to you FREE. Not a cent to pay until you see the books. No obligation to buy unless you are satisfied. Send coupon now—today—and get this great help library and see if it is not worth $100 to you—you pay $1.00 a month for 10 months or return it.

SEND NO MONEY

THEO. AUDEL & CO., 72 Fifth Ave., N. Y. Please submit for examination Hawkins Electrical Guides (Price $1 each). Ship at once, prepaid, the 10 numbers. If satisfactory, I agree to send you $1 within seven days and to further mail you $1 each month until paid.

Signature_____

Occupation_____

Employed by_____

Residence_____

Reference_____ P. P' E.

EQUIPMENT FOR SALE

Shout It Aloud

If you have something to sell you don't go into a secluded corner and whisper the news.

You will go where the people are and state your proposition. You won't whisper, either. You want attention!

You can't talk loud enough to be heard by 24,200 buyers or sellers at once. Of course you can't.

But in the Signboard Section you can SHOUT the live news of what you have to offer in tones that will be heard throughout the Nation—directly into the ears of men in 24,200 power plants who do the buying for these plants—ears attuned to your message by their own plant needs.

If you have new or second-hand power plant equipment to sell—SHOUT the news—through these columns.

You'll be heard—far and near! You'll get action—quickly! Just try it! Send in your advertisement—NOW.

SHOUT IT ALOUD IN THE

Signboard Section

EQUIPMENT FOR SALE

Excellent Buy In HRT Boilers

(First-Class Used)

3-78 x 20 Shells 9/16" BS 4-R, Suspended Shak. Grates. 125 lb. to 150 lb. in Code States.

2-72" x 16' Shells 7/16" BS 4-R, Bracket. Plain Grates, 125 lb. reset at factor 5.

4-72" x 16' Shells 7/16" BS 3-R, Bracket. Plain Grates, 125 lb. reset at factor 5.

3-72" x 16' Shells 7/16" BS 3-R, Bracket. Plain Grates, 115 lb. reset at factor 5.

All located at Kenosha, Wis.; owned by us, and offered at very attractive prices for quick sale. Eight boilers out of setting now. Hart. Inspect.

2-72" x 18' HRT Boilers; Shells ½", BS 3-R. Bracket. Shak. Grates, 125 lb. reset at fact. 5., located Kankakee, Ill. Out of setting. Ready to ship.

Write, wire or 'phone our expense.

R. L. Baker

30 N. La Salle. Frank. 1520. Chicago.

150 H. P. Engine For Sale

Owing to alterations in our power house, we have available for immediate removal one Corliss Non-Condensing Engine.

Fly wheel, 12 section, 16 ft. diameter, 25 in. face:

Main Shaft, Wrought iron, 10 inch diameter:

Shaft Bearings, 9 inches diameter, 18 inches long:

Cylinder, 18 inches diameter and 42 inch stroke:

Engine equipped with ball governor and Springfield Automatic Stop.

Can be inspected at our Brooklyn Works. Phone, or write at once to F. C. W.

J. H. Williams & Co.

150 Hamilton Avenue, Brooklyn, N. Y.

'Phone Henry 2000, Ext. 47

For Sale

Two Ames Horizontal Tubular Boilers (54x14)

125 pounds working pressure, 36 four-inch tubes each, butt joint type, built in '915, have had light use, and are in very good condition, complete with full cast-iron fronts, suspension beams and all fittings. We are discontinuing the use of steam power."

Potter-Casey Co., Inc.

Aitkin, Minn.

SIGNBOARD SECTION

Quick Action Opportunities

EQUIPMENT FOR SALE

Three Boilers for Sale

shell 66 inches in diameter, 18 feet long, overhang fronts, 54 4-inch tubes.

1 Vilter 22 x 42 Corliss Engine complete with oil cups, etc.

1 125-volt 40-amp. D.C. Northern Generator, direct connected to an upright Baylor Engine, complete with volts and ampmeter, also reostade.

WISCONSIN ICE & COAL CO.
Milwaukee, Wis.

For Sale
250 KVA. ENG.-GEN. SET

1—250-Kv a. Fort Wayne A.C. Generator, 220 volts, 60 cycle, 3 phase, Revolving Field, direct connected to 15½"x27"x 21" Erie City Side Crank, L. H. 4-valve engine. Unit modern in every respect. Used very little. Specially attractive price and quick delivery. Write or wire our expense for full particulars.

R. L. BAKER
30 N. La Salle St., Chicago

For Sale—Boilers

We offer subject to prior sale the following used boilers:

10—B & W 275 H.P., 125 lbs. pressure.

12—Sotter Bros. 140 H.P., return tubular, 90 lbs. pressure.

CHIEF ENGINEER'S OFFICE
National Sugar Refining Co.
of N. J.
Yonkers, N. Y.

TRANSMISSION

Having changed our power equipment, we have for sale:

2 Sheaves, 60" Diam., 13" Face.
3 Sheaves, 40" Diam, 13" Face.
1 Sheave, 40" Diam, 11½" Face.
2 Sheaves, 40" Diam, 2" Face.
Bearings, Pulleys, some Belting.

Write for more definite information.

Atlantic Mfg. Co.
Wilmington, Del.

EQUIPMENT FOR SALE

Must Move at Once

The 75 Kv. d. c. Busch-Sulzer Westinghouse oil engine unit which is now in our plant.

Construction has reached a point where we must dismantle the machine and take it from the engine room. It is still in operating condition. Come and inspect it while you can.

No definite price on the machine. Make us an offer after you see it.

International Time Recording Co.
Endicott, New York

In one of our recent big purchases we secured a number of

New Water Tube Boilers

Which We Offer for Quick Sale

200-225-250-275-300 H. P.

Heine—Colvin—Foster

and Other Standard Makes

Immediate shipment. Located at points throughout the country.

Send for Boiler Bulletin

HARRIS BROTHERS CO.
1475 W. 35th St. Chicago, Ill.

EQUIPMENT FOR SALE

FOR SALE
Direct Connected Units (a.c.)

KW	Generator	Engine
750	Al. Chal.	Al. Chal.
500	Al. Chal.	Al. Chal.
400	Al. Chal.	Al. Chal.
300	G. E.	McI. & S.
300	Burke	Skinner Uniflow
300	G. E.	Curtis horiz. turbine
250	Al. Chal.	Al. Chal. Cross-comp., 200 r.p.m.
225	Wghse.	Al. Chal.
200	Al. Chal.	Al. Chal.
175	Al. Chal.	Al. Chal.
150	G. E.	Buckeye
125	G. E.	Erie Ball
100	Al. Chal.	Erie Ball
100	C. W.	Ridgway
90	G. E.	Chuse Uniflow
70	G. E.	Ideal
60	Elec. Mchy.	Skinner

Power Machinery Exchange, Inc.
1 Montgomery St., Jersey City, N. J.

FOR SALE

Three 150 KW., 275-Volt D.C. Generators, belted to Ridgway engines, units complete with switch board. A No. 1 condition. Immediate delivery, attractive price. One or all.

M. C. BENEDICT
Box 281 Johnstown, Pa.

One 13x34 Brown Engine, used 3 years.
One 5" Warren Steam Separator.
One 8" Cochrane Oil Separator.
And other equipment.

FOSTER ASSOCIATES, INC.
116 Exchange St., Worcester, Mass.

The Fuel Economy Number

The January 1, 1921, Specialized Issue of POWER PLANT ENGINEERING

If oil refining were suddenly to go back to the methods of a few years ago and lose the vastly increased percentage of gasoline now obtained from the crude oil, more than half the automotive vehicles of the country would be laid up for want of fuel.

The whole tendency in industry of the present generation has been to refine, improve and perfect processes and methods to offset the growing scarcity of basic resources.

Packing industries have utilized every last by-product of animals from glandular extracts for medicine to tendons and tissues for violin strings and tennis rackets.

Mining has developed the flotation and other processes which have caused the ore dumps of a former generation to yield millions of dollars worth of refined metals.

Power plants are now feeling that inexorable law of Nature, the survival of the fittest. Fuel prices force the issue.

Men responsible for power generation will rise or go down in their profession, not by their ability to run existing plants, but by their judgment in improving operation, selecting better equipment and boldly taking the initiative toward every practical means of **reducing fuel costs.**

To ever be of the utmost practical help to these progressive men in the engineering field who are its readers, POWER PLANT ENGINEERING is bending every effort toward making its January 1st, 1921, number the most vitally and permanently helpful of all its annual specialized issues.

That this is a high standard is evidenced by the universal esteem in which the 12 previous annual issues have been held by the engineering profession. Each of these issues has treated exhaustively some one special phase of power plant practice.

Besides its splendid editorial contents, the Fuel Economy Number will be a veritable exposition of the most reliable firms making the most modern equipment, and its advertising and editorial pages will be the almost daily reference guide of consulting engineers, operating engineers, purchasing agents and every man who has to deal with any phase of the present and future conditions under which power must be generated, distributed and utilized.

The text-book character and constant reference value of this Fuel Economy Number will develop a demand for many extra copies, as has been the case with previous specialized January 1st issues of POWER PLANT ENGINEERING.

While all regular subscribers will receive this splendid number as a regular issue, in the larger firms where POWER PLANT ENGINEERING is passed on from desk to desk, extra copies are desired to avoid constant reference to the office file.

That no one may be disappointed, as has been the case in former years, when we have received hundreds of orders for extra copies which we could not fill, we urge you to consider your requirements and

Order Extra Copies Now

50 Cents—Postage Prepaid

Included with All Regular Subscriptions at $2.00 a Year up to and including the 5th zone and $2.50 in the 6th, 7th and 8th zones

SEND ALL ORDERS AND REMITTANCES TO THE

Technical Publishing Co., 537 S. Dearborn St., Chicago

Let The War Department You As Others

WHEN you want certain materials or equipment at a certain time at a certain price you want above all, QUALITY.

Here and now is the chance to step in and acquire such equipment as you may or will need, under the most favorable conditions, and above all equipment that will stand up.

The War Department's long standing, much envied "quality first" specifications prevail in each and every offering; a fact that is being realized on from day to day by leading manufacturers, in that they are buying large quantities of War Department Surplus Properties.

These firms, doing a tremendous volume of business, have a hard earned reputation to maintain; they are not buying blindly, they buy only after careful inspection, and according to their well known reputable standards of quality.

These firms, representative of Big Business, know the pulse of the markets; they must in order to exist, they fully realize that bigger, better business is on the way. Accordingly, they are buying from the War Department at prices more favorable than those of the open market. Big Business leads the way; Big Business forms the criterion that is safe to follow.

What Big Business does, Little Business can do; the opportunity is there for all.

Profit by the example of others and join the ranks of Progressive Business

Erie Engine, S.P.D. No. 16607. One 20 H.P. simple double action, horizontal cylinder steam engine, diameter of cylinder 8 inches, length of stroke 10 inches. Mfr. Erie City Iron Works, Erie, Pa. Location: Fort Leavenworth, Kansas. Fixed Price, $400.00.

Air Tanks, S.P.D. No. 10634. Without cases. Tested to 2050 lbs. pressure. Quantity for sale 2,717. Mfr. Harrisburg Pipe & Pipe Bending Company, Harrisburg, Pa. Location: Philadelphia, Pa. Fixed Price, $1.00 each.

Blow-Off Valves, S. P. D. No. 14733. Brass, 1½ inch. Straight blowoff valve for working pressure up to 200 lbs., both female ends. Quantity for sale 295, all in good condition. Mfr. Wm. Powell & Co., Location: Norfolk, Va. $4.00 each.

Condenser Tubes, S.P.D. No. 4450. 2000 lbs. Muntz metal composition, ⅝ inch, tinned inside and out, 14 feet long, in good condition.

Quantity for sale, not tinned, Muntz Metal composition, 2380 lbs., ¾ inch, 16 feet long. Mfr. Bridgeport Brass Co., Bridgeport, Conn. These items are located at Boston, Mass. Fixed Price, 24 cents per lb.

New York, 461 Eighth Ave., New York City.

Chicago, 1819 West 39th St., Chicago, Ill.

Boston, Army Supply Base, Boston, Mass.

Atlanta, Transportation Bldg., Atlanta, Georgia.

San Francisco, Fort Mason San Francisco, Calif.

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ent Supply Cannot

The items listed here are also offered for sale by the War Department. Look them over carefully and write to the Depot Quartermaster who is located nearest you for complete information. The list of Depot Quartermasters addresses is given below on preceding page.

Knocked down Boilers, from 10 to 125 H. P., both Horizontal and Vertical.
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Use this coupon today. Upon its receipt the War Department will send you a booklet covering the various materials and equipment they are offering for sale by fixed prices in M. & E. M. List No. 10.

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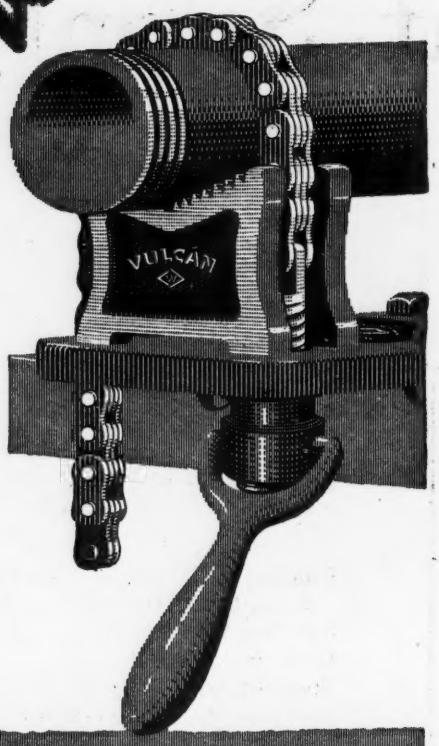

In general, you know there's no comparison between a cast and a wrought tool.

The same principle applies to pipe vises.

Williams' "Vulcan" No. 4, for ⅜ to 8-inch pipe, is stronger, quicker in action and cheaper.

3 sizes for ⅛ to 8-inch pipe—at your dealer's. *Ask for Catalog*

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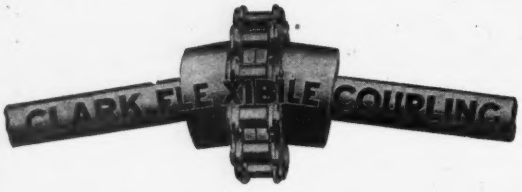

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Shafts Either in Line or at Angle

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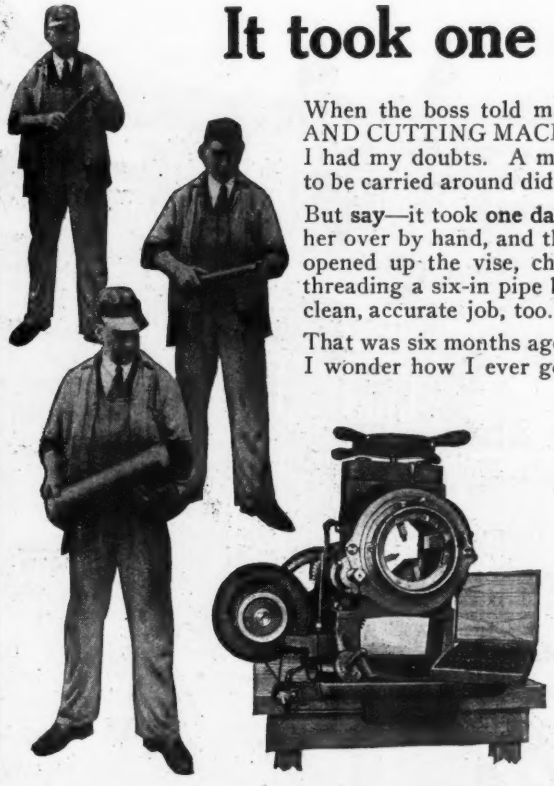

It took one day to convince me!

When the boss told me he was getting a FORBES' PIPE THREADING AND CUTTING MACHINE to do all the pipe work at the shop **or on the job,** I had my doubts. A machine big enough to do the work, and small enough to be carried around didn't seem possible.

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That was six months ago. I've used the FORBES' on every job since, and now I wonder how I ever got along without it!

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Many P. & C. Valves are still giving satisfactory service after more than a quarter of a century of use.
Made of bronze and iron, in sizes and styles to meet every requirement.
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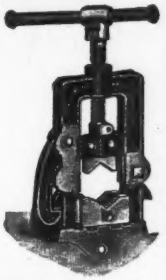

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It is made of the best malleable iron, with jaws of the best hardened steel and on the interchangeable system any part can be replaced.

Simple in construction, strong and always dependable.

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A convenient, one-piece die stock which threads ¼, ⅜, ½ and ¾-inch pipe—without changing dies or bushings.

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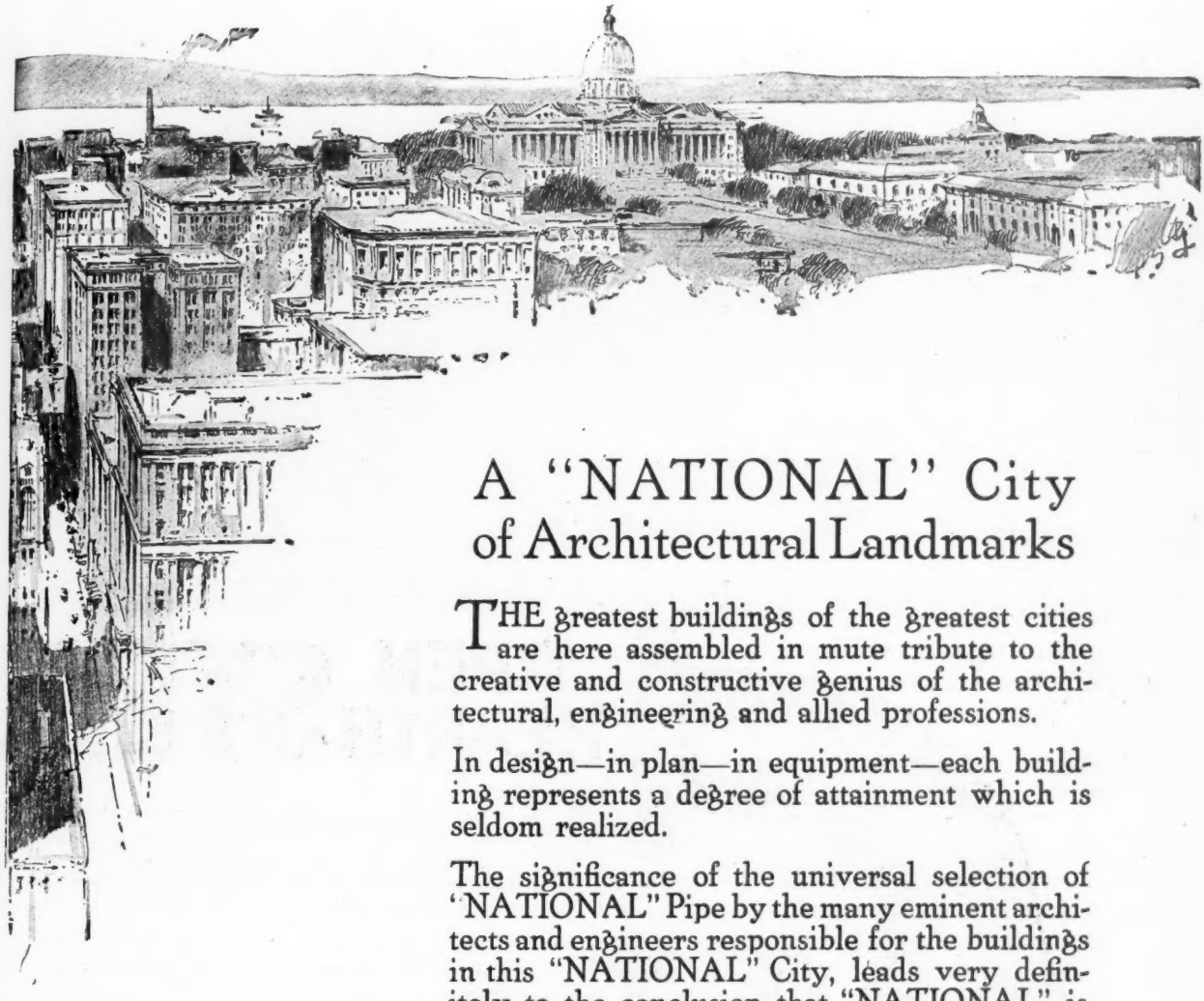

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In design—in plan—in equipment—each building represents a degree of attainment which is seldom realized.

The significance of the universal selection of "NATIONAL" Pipe by the many eminent architects and engineers responsible for the buildings in this "NATIONAL" City, leads very definitely to the conclusion that "NATIONAL" is always the prefix of pipe satisfaction.

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Standard Steel Fittings have a working pressure

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Medium Steel Fittings have a working pressure up 250 pounds. Tested to 1,000 pounds hydrostatic ressure.

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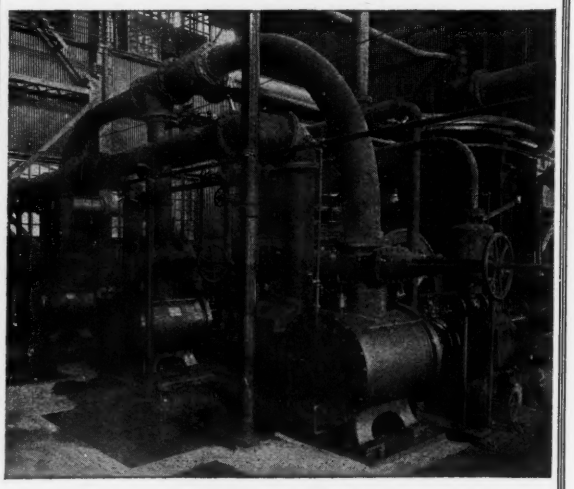

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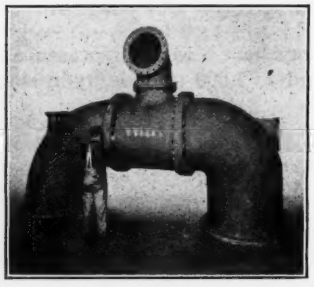

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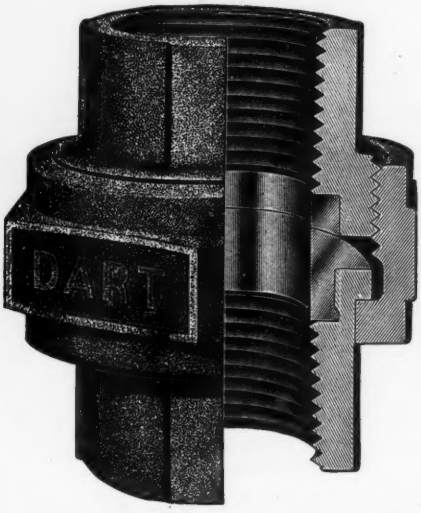

In the construction of

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the bronze-to-bronze seats stand out foremost as strength and double-service-giving features. The threads on the malleable iron pipe ends are long, clean and full standard size.

Every plant owner, engineer or foreman should be familiar with the "Union with the Bronze-to-Bronze Seats," and the simplest way is to send for a sample and try one where service is most severe. Also he should send for our new Catalogue "T," wherein all the details are given.

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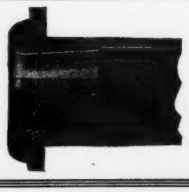

By Strengthening the Weakest Part

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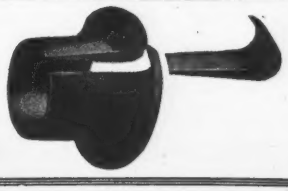
add years of service to your boilers. Their cost is but a trifle, they are easy to attach, and they afford a practically new set of tubes. Write for particulars.

Telephone 45-R and 526-R **CRUISE & COMPANY** 144-150 Broadway ELIZABETH, N. J.



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PURIFICATION SYSTEMS
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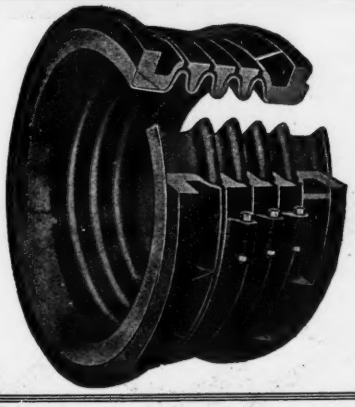

BADGER
SELF-EQUALIZING EXPANSION JOINTS

Prevent leaks in all pipe lines

E.B.Badger & Sons Co.

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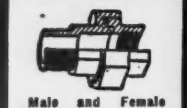

Male and Female Union. Does away with a nipple and makes a short connection.

Jefferson Flange Union. Brass-to-iron ball joint. Made in eighteen sizes, from ½ to 12 inches.

All Male Union. Saves two pipe joints between two female threaded parts.

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JEFFERSO

In this Union there is Service

Wherever Jefferson Unions are installed *The Triple Alliance* of employer, engineer and workmen is formed in endorsement of their service.

As there is no greater source of dissatisfaction in the power plant than leaky Unions, so there is no surer means of creating co-operation than by adopting "Jeffersons".

To the owner they yield profits accruing from sustained economy of operation under severest strains; to the engineer they impart the sense of accomplishment and satisfaction that dependable equipment gives; and to workmen they insure safety and freedom from constant replacements.

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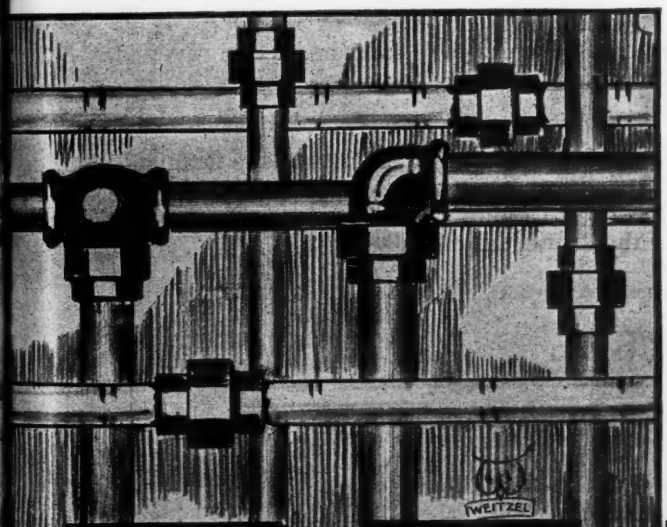

Superior strength is thus built into the *Jefferson Union*. Write for a catalogue, describing the patented features found only in the Jefferson. You will be convinced of its capacity to give enduring, trouble-free service.

Always look for the name "Jefferson" stamped on the nut. Insist that your jobbers furnish Jefferson Unions.

Jefferson Union Company

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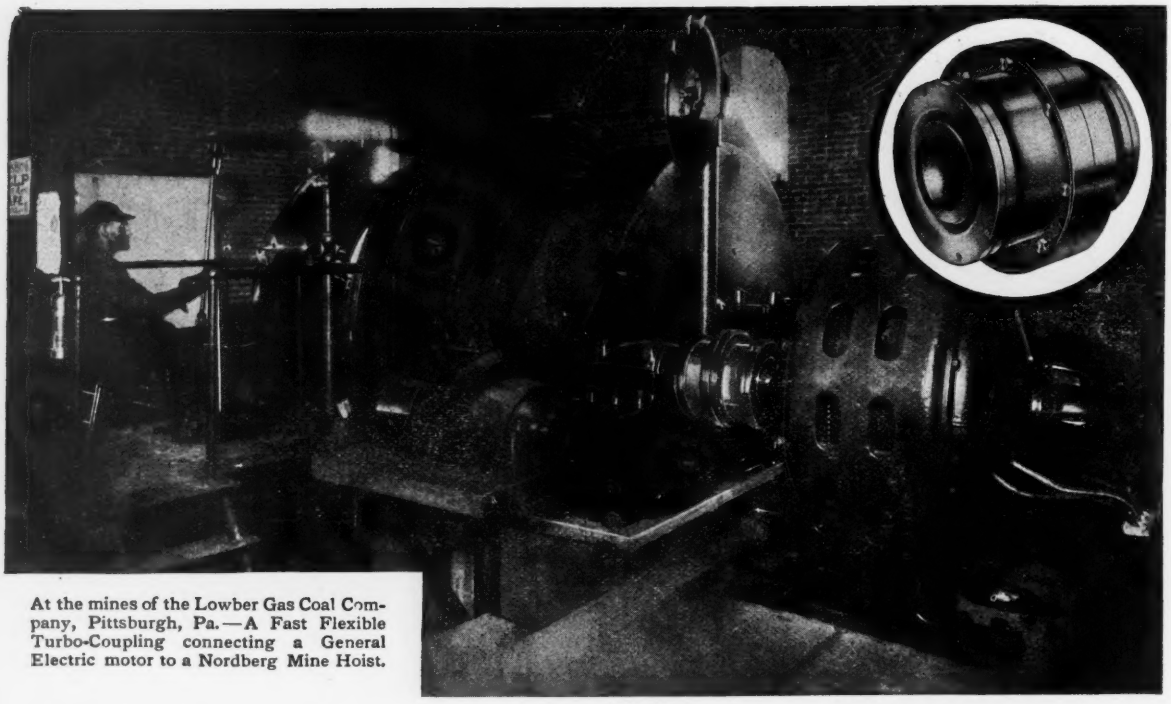
Union Tee, with union on the outlet. Made also with male end on outlet.

Jefferson Union Tee with union on the run. Has union end threaded either male or female.

Union Elbow, an economizer of the most pronounced type. Also made all female.

Union Elbow, all female. Takes place of straight union nipple and elbow. Made male and female.

ON UNIONS



At the mines of the Lowber Gas Coal Company, Pittsburgh, Pa.—A Fast Flexible Turbo-Coupling connecting a General Electric motor to a Nordberg Mine Hoist.

FAST FLEXIBLE TURBO-COUPLING FOR MINE HOISTS

Mine hoist operation, on account of the constant change of load and rapid reversal of rotation, calls for a flexible coupling of exceptional merit. The Fast Flexible Turbo-Coupling is ideal for reversing loads.

The flexibility of this coupling is due exclusively to its design and not to the flexibility of the materials from which it is constructed. It durability is therefore not limited by the fatigue of the materials. Positive lubrication of the contact surfaces insures constant operation and a coupling life equal to that of the connected machines.

Our catalogue sent on request.

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What the Fast Flexible Turbo-Coupling does.

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5. Provides for incident lateral movements of shafts of the connected machines.
6. Because lubricated and dustproof, will operate continuously where dust, dirt, dampness or heat are unavoidable.
7. In capacity to transmit horse power, in any given size, at high or low speed, it has no equal.

FAST FLEXIBLE TURBO-COUPLING

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Mark Unions have never failed to live up to their name.

Try a Mark—put it to a rigid test and be convinced of its many merits.

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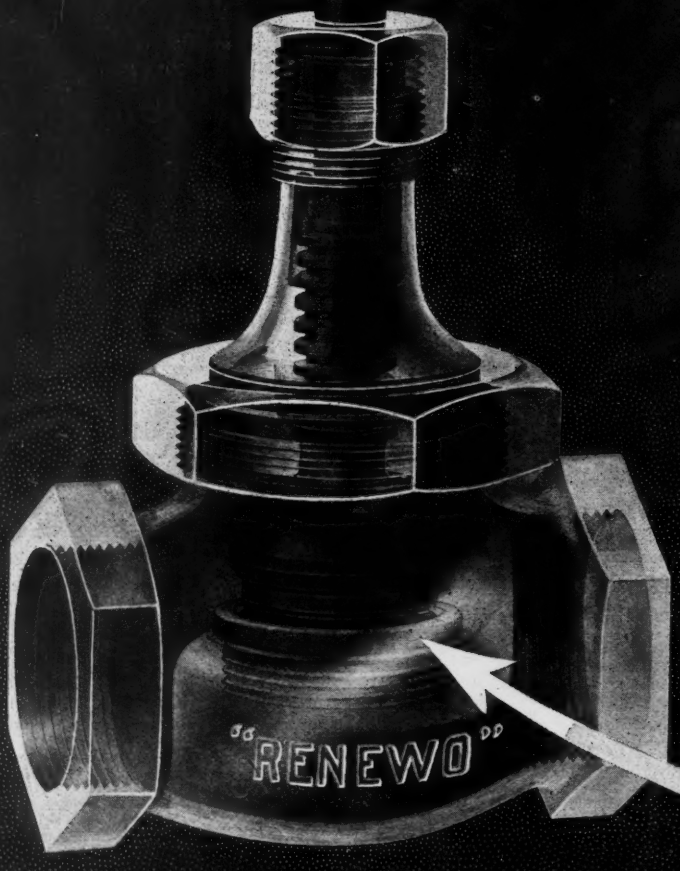
—made to last a LUNKENHEIMER "RENEWO"

Have achieved an enviable record for economy in steam service. They represent the highest development in valve construction, incorporating all the good features discovered and developed in over half a century of valve manufacture.

Their installation means permanence in the line, because they are as near wear proof as can be attained, and to further enhance their durability all the parts are interchangeable and can be replaced should necessity require.



AMERICA'S BEST
LUNKENHEIMER
"QUALITY"
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long time VALVES

"Renewo" Valve parts are made of materials best suited to the duty the part performs.
The ***Renewable Seat*** and ***Disc*** are made of Lunkenheimer "Valve-nickel," a material having exceptional wear-resisting qualities; the Disc is provided with the celebrated Lunkenheimer "Seat-guard" which aids in preserving the seating faces and keeping them clean, and the seating surfaces are regrindable. The stem is made of a special bronze; the thread is extra long and has full contact when valve is opened or closed. The union bonnet connection with outside protected threads; deep stuffing box with gland follower, and the self-cooling malleable iron handwheel are other points of merit.

Globe, Angle, Cross, Straightway or Y and Horizontal and Angle Check Patterns for 200 and 300 pounds working steam pressures. Specify LUNKENHEIMER "RENEWO" and insist on having the genuine.

Write for descriptive booklet F535—DD

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"QUALITY"
LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD
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They wanted dependable valves

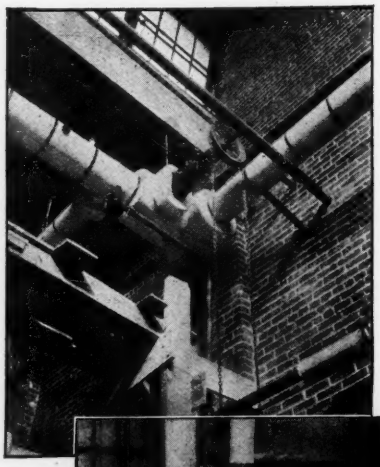
that's why Jenkins were installed

The Windsor Manufacturing Co., manufacturer of woolens, recently built a new plant in Philadelphia.

High standard equipment was installed throughout. And when it came to valves, "Jenkins" were the logical choice.

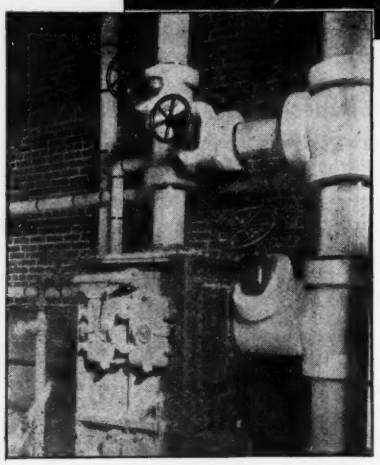
You, too, can install Jenkins Valves with confidence in their satisfactory performance. Back of every Jenkins Valve is manufacturing experience that extends over a period of more than fifty-five years. Knowing valves and valve requirements has shown us how to build a valve that is dependable under every condition. And that is because each "Jenkins" in every type is made for the maximum service, not merely the average.

Jenkins Valves are made of brass, iron, and steel in types and sizes to meet all requirements. Know the genuine by the name and Jenkins Diamond Mark cast on the body—at supply houses everywhere.



10" Jenkins Medium Pressure Iron Body Gate Valve with yoke and outside screw. Installed on main Feed Line working under 150 lbs. pressure. (Fig. 253).

2" Jenkins Extra Heavy Brass Globe Valves (Fig. 128) and swing Check Valve (Fig. 260) on boiler injection line. 3" Jenkins standard Iron Body Gate Valve (Fig. 325).



Jenkins Medium Pressure Iron Body Gate Valves on lines running to water heater. Two 8" (Fig. 255) and one 10" (Fig. 251).

JENKINS BROS.

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St. Louis Boston San Francisco Pittsburgh
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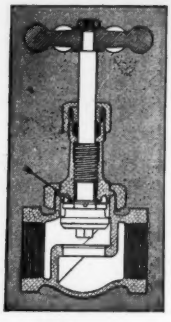


Williams Regrinding Valve No. 107

Showing the high lifting Williams disc—arrow indicates small steam-tight seat on stem which enables you to repack under pressure with absolute safety.

No Stops for Packing-No Accidents

"There's a valve that needs repacking. Attend to it!"

"That's easy—it's a **Williams.**"

Work isn't all grief when such a valve needs attention. You can open it to the limit under 200 lbs. pressure and repack easily, quickly and with perfect safety.

Have you that kind of valve service or are you still putting up with old style valves that necessitate overtime, breed discontent, foster accidents, and waste steam?

The men who buy Williams Valves are big men who know the best and get it. That is why the great steel industries of the Bethlehem and Pittsburgh districts install them. They mean smooth, uninterrupted service and contented workmen.

There are other Williams features worth knowing about. Catalogue 10 gives all the facts. It's interesting. Write for it.

THE D. T. WILLIAMS VALVE CO.
CINCINNATI, OHIO

(12A)

Williams Valves

HOMESTEAD
Quarter-Turn Valves

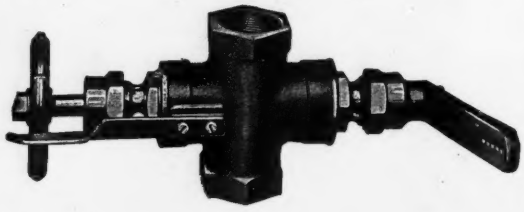
Are Dependable

Straightway 500 Lbs. Working Pressure

The large number of Homesteads installed where safe and steady operation is paramount, in mills, mines, and railroads, prove their dependability.

Order your requirements today

Homestead Valve Mfg. Co.
Homestead, Pa.
242 Lafayette Street New York City



Closest Draft Regulation

depends upon a valve which can be adjusted to effect gradual changes in the speed of the fan engine. Specify

Variable Opening Trade Mark R-K Reg. U. S. Patent Office **Chronometer Valve**

operated by an **R-K Improved Fan Engine or Damper Regulator.** The result will be uniform speed regulation free from hunting action.

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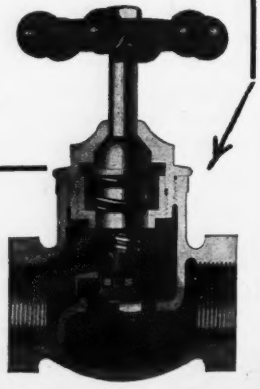
L. E. Pollard Co., First National Bank Bldg.....Omaha, Neb.
Baumes-McDevitt Machinery Co., Railway Exchange Bldg.....St. Louis, Mo.
Baumes-McDevitt Machinery Co., 205 Scarritt Bldg.....Kansas City, Mo.
Rochester Vacuum Valve Co., Cox Bldg.....Rochester, N. Y.

There's a Reason for The Undisputed Success of Sandusky Packless Valves

Any chance for economy is welcomed with enthusiasm now when increased prices, wages and expenses prevail. That's why the packless feature of Sandusky Valves has gained for them a national reputation for giving maximum valve service at a minimum cost, and at the same time eliminating packing troubles. They are absolutely steam tight at Stem, Seat and Body. No complicated parts.

Try some at our expense for 90 days, in the toughest places. Will refund your money if they do not prove satisfactory.



The Sandusky Packless Valve Company
1209 W. Adams Street
Sandusky, Ohio
New York Distributor:
Advance Engineering Co., 168 Washington St., New York City.

STRONG
Non-Return Stop Valves

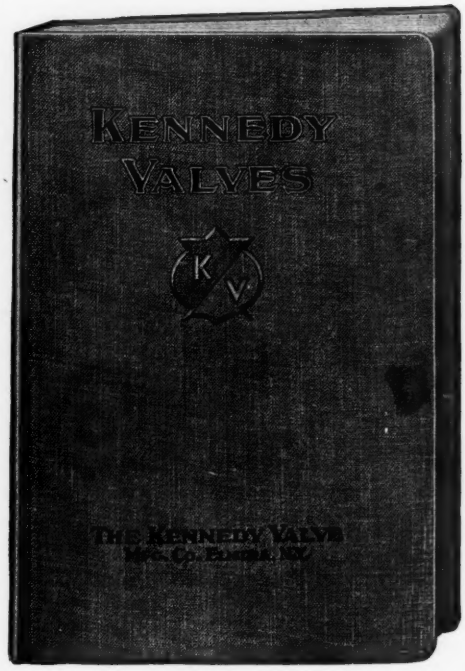
continue their proper functioning regardless of accumulating corrosion, dirt, scale or sediment.

The firemen are guided in locating a lagging boiler by the outside lever, which shows whether the valve is open or closed. As the valves cannot be opened by hand, protection is afforded the men who may be at work within a boiler which is laid up for repairs.

Strong Non-Return Stop Valve acts automatically and instantly in emergency. Shuts off steam whenever pressure is lowered. Protects boilers, plant and production when accident occurs.

It will pay you to investigate. Write for our Catalogue T-30.

The Strong, Carlisle & Hammond Co.
Manufacturers of a Complete Line of
Steam Traps, Vacuum Traps, Steam and Oil Separators, High and Low Pressure Reducing Valves, Pump Governors, Engine Stops, Emergency Check Valves, etc.
CLEVELAND, OHIO



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—a practical reference book for all valve users; convenient in size and arrangement. More than 500 different types and sizes are described and listed—a range that covers all usual requirements.

If you use valves, you should have the Kennedy Valve Book—it explains the principles of modern valve design, points out the features of construction necessary to assure satisfactory valve service, helps to make an exactly suitable selection for your particular purposes, and gives practical suggestions for the proper installation and care of valves.

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CHICAGO, 204-8 N. Jefferson Street.
Export Office: 95 John Street, New York, N. Y.
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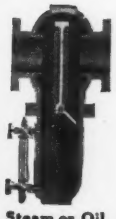
170-B

JOHN DAVIS CO.

Eclipse STEAM SPECIALTIES

THE STANDARD FOR OVER 35 YEARS

ILLINOIS ENGINEERING CO., CHICAGO.



Steam or Oil Separator

Write for Bulletins on the following:

Reducing Valves
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Non-Return Valves
Stop and Check Valves
Extra Heavy Globe Valves
Vacuum Return Valves
Radiator Supply Valves
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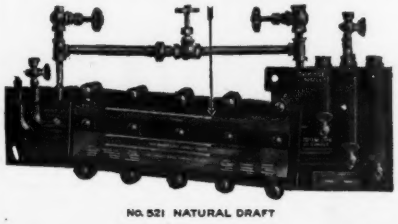
Separators

Not A Meter—Not A Gauge—No Readings—No Charts

PRODUCTO COMBUSTION GUIDE

Guaranteed To Save 10 to 25 Percent In Coal



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Progress Products Co.—1313 Race St.--Philadelphia

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If you require: Tanks, Stacks, Oil Storage Tanks, Pressure Tanks or Steel te Construction of any kind, specify

L-A-N-C-A-S-T-E-R

Lancaster Iron Works Inc.
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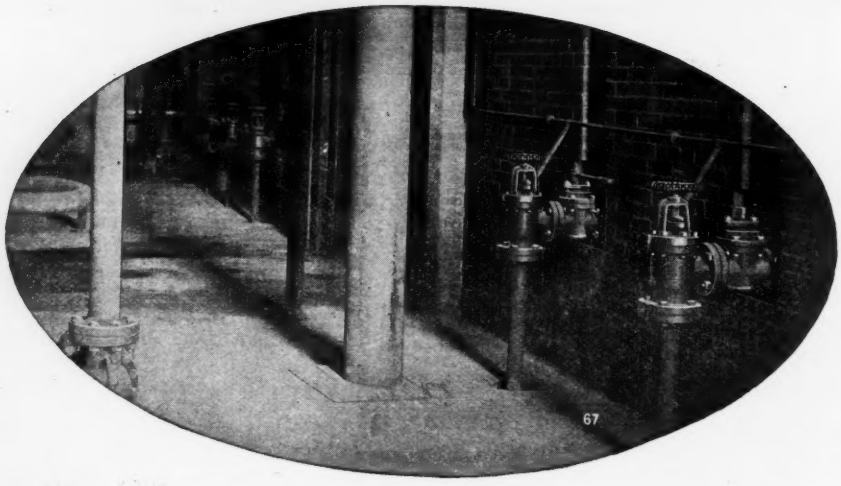
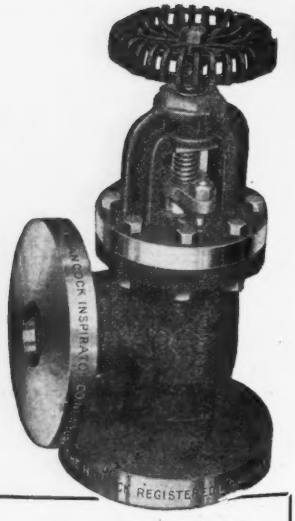
NY OFFICE-501 FIFTH AVE. BOSTON OFFICE-88 BROAD ST.





Five years a blow-off valve without regrinding— that's Hancock Service

There are few places that more severely test the worth of a valve than blow-offs. The abrasive action of the sediment together with the corrosive action make a combination that few valves can withstand.

Engineers who don't use Hancocks say that they have to regrind frequently and replace blow-off valves every year. But Hancock users don't have that work. Those special renewable nickel discs and seats are little affected by the sediment; their design keeps them clean so that they close *tight* with little effort. They often last five years or more on severe service.

Want to be convinced? Send us size and steam conditions and we'll send you a Hancock on trial. Put it to the hardest tests you can think of. There is no obligation.

HANCOCK FEATURES

"Zero" hand wheel is always cool.

Bronze Composition Stem with Acme thread guaranteed 100,000 operations.

Stem guided at three points—cannot warp.

Narrow Bonnet seat insures tight joint and prevents sticking.

Disc cannot become cocked.

Renewable disc and seat of special bronze or nickel according to use.

Valve can be packed without shutting off steam, even if high-pressure superheat.

Projecting lip on disc cleans seat just before closing valve.

Cylindrical form of body enlarges steam areas, reducing friction.

Special bronze and nickel alloys used are combined from pure metals in our own plant.

Bronze body valves guaranteed up to 500 degrees. Steel body valves for higher temperatures.

Hancock Valves are proven by years of service. Everyone *must* give satisfactory service or we will refund your money.

The HANCOCK INSPIRATOR COMPANY
SALES DEPARTMENT OF
MANNING, MAXWELL AND MOORE, INC.
119 West 40th St. NEW YORK 29 North Jefferson St. CHICAGO
Consolidated Safety Valves, Hancock Inspirators, Hancock Valves, Metropolitan Injectors

MMM-96

HANCOCK VALVES

"I Know My Boilers Are Safe—

I can test this valve right in service"

Yes, sir—certainty that my boilers are being protected against the sudden reversal of steam flow is always at hand.

All my boiler connections between the nozzle and the header are equipped with

Golden-Anderson

Patented Automatic Double-Cushioned Triple Acting and Non-Return Valves

1. They are the only valves that can be tested in service from the boiler room floor. Opening a small hand valve will give complete assurance that the big valves are faithfully on guard against disaster.
2. They automatically cut out a damaged boiler and prevent the back pour of steam from the other boilers through the rupture. That means **no shutdown.**
3. They automatically equalize the pressure between all boilers and positively prevent steam from entering a cold boiler in which the engineer may be at work.
4. The double Corliss Dash Pot gives absolute relief from pounding, sticking and chattering. It protects the valve and you.
5. The valves can be closed instantly from distant points by steam or electricity.
6. When fitted with our patented safety latch they may also be opened by hand like an ordinary stop valve.

Angle, Globe or Elbow Pattern

Also made in the triple acting style that works "both ways" causing instant automatic closure of the valves on every boiler in case a steam pipe lets go.

1960 used by U. S. Steel Corporation

after making thorough tests of all well-known makes

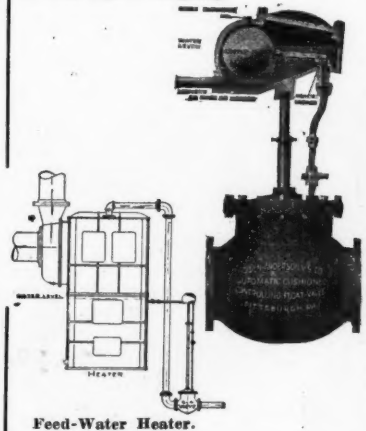
"Life and Property Insurance Valves"

"No shut-down when a tube bursts"

Golden-Anderson Pat.

Automatic Cushioned Controlling Float Valves

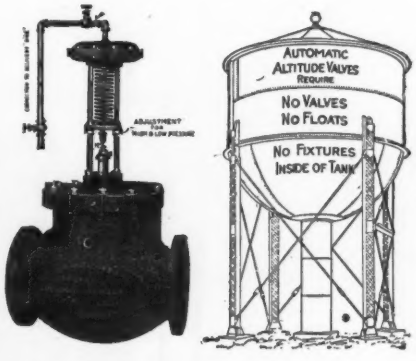
1. They carry a constant water level in feed water heaters by perfectly controlling the flow of make-up water.
2. Operated by protected enclosed copper float.
3. Cushioned by both air and water.
4. Operate without hammering, sticking or chattering. No metal-to-metal seats.
5. Made angle or straightway.



Feed-Water Heater.

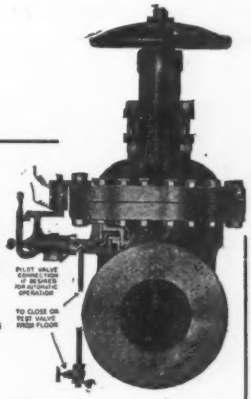
Golden-Anderson Patented

Automatic Cushioned Controlling Altitude Valves



1. Eliminate loss of water in reservoirs, standpipes, tanks, etc., by keeping the level constant.
2. Operate without floats or fixtures.
3. Uninterrupted service and a positive water supply assured without danger of water hammer surges or burst mains.
4. No metal-to-metal seating. Positively cushioned by water and by air.
5. Can be made to close automatically during fire service.
6. Can be controlled by water or electricity from distant points.

Golden-Anderson Double Cushioned Quick Closing Emergency Trip Valves



Provide Against Runaway Engines and Disastrous Accidents

Features:

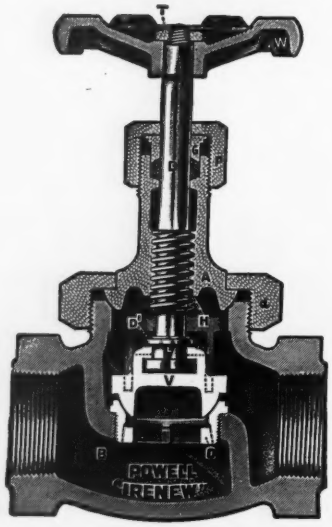
1. Electrically operated from distant points.
2. Emergency tripped by small branch pipe connection.
3. Hand operated by hand wheel.
4. Double cushioned by Corliss dash pots—positively no hammering or pounding.
5. Double extra heavy throughout—practically indestructible.
   Suitable for any pressure—no adjustments.

"Hosts of References"

Golden-Anderson Valve Specialty Co., 1287 Fulton Bldg., Pittsburgh, Pa.

POWELL

"IRENEW"



VALVES

ALL PARTS RENEWABLE

Globe, Angle, Cross, or Check Valves

Iron body, brass mounted; acid-proof discs and seat rings; for steam, water, oil, air or chemicals; screwed or flanged ends.

Ask your dealer for

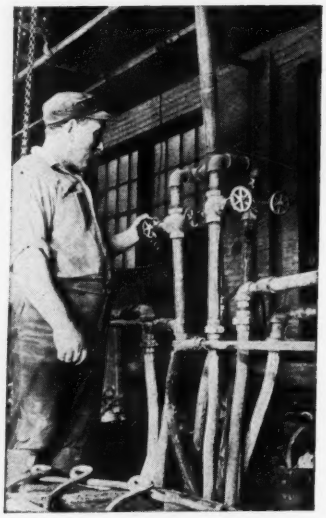
Powell Super-Service Irenew Valves

or write us

THE WM. POWELL CO.

DEPENDABLE ENGINEERING SPECIALTIES.

CINCINNATI, O.



O-B J. D. Valves for Shutting Off Steam or Water Tightly

O-B J. D. Valves are accurately built. The simplicity of their design insures quick and accurate operation. The strength of their construction enables them to perform perfectly under heavy strains.

Buy Valves with the O-B Trade Mark from your supply house.

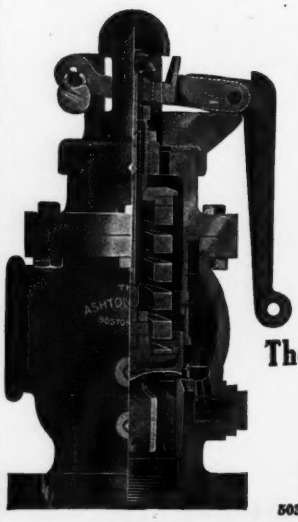
THE OHIO BRASS COMPANY

MANSFIELD, OHIO

50 Years in Service

Ashton Valves have been giving successful service in power plants for almost 50 years. Each year they give greater and more service than the one previous, for new firms are constantly recognizing the many advantages which make them invaluable as steam and money savers.

Ashton Pop Safety Valves



relieve excessive steam pressure, avoiding disastrous accidents. Unnecessary blowoffs are prevented by the automatic action, which blows off excess steam in just the right amount. When once locked, the Ashton cannot be tampered with.

To insure your plant against coal waste and valve troubles, install Ashton Service in your plant immediately. Write for free literature.

The Ashton Valve Co.

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Cambridge C,
BOSTON, MASS.

BRANCH OFFICES:
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318 W. Washington St., Chicago
503 Mission St., San Francisco

Chapman Valves Respond Unfailingly

They transform every point of unusual strain into a point of strength.

Chapman Valve design presents unyielding resistance to every stress; lasting service at every point of wear.

Each Chapman Valve is designed expressly for some specific service in the power plant and is the best valve that intelligent engineering supervision and honest workmanship can produce for that service.

BRANCH OFFICES

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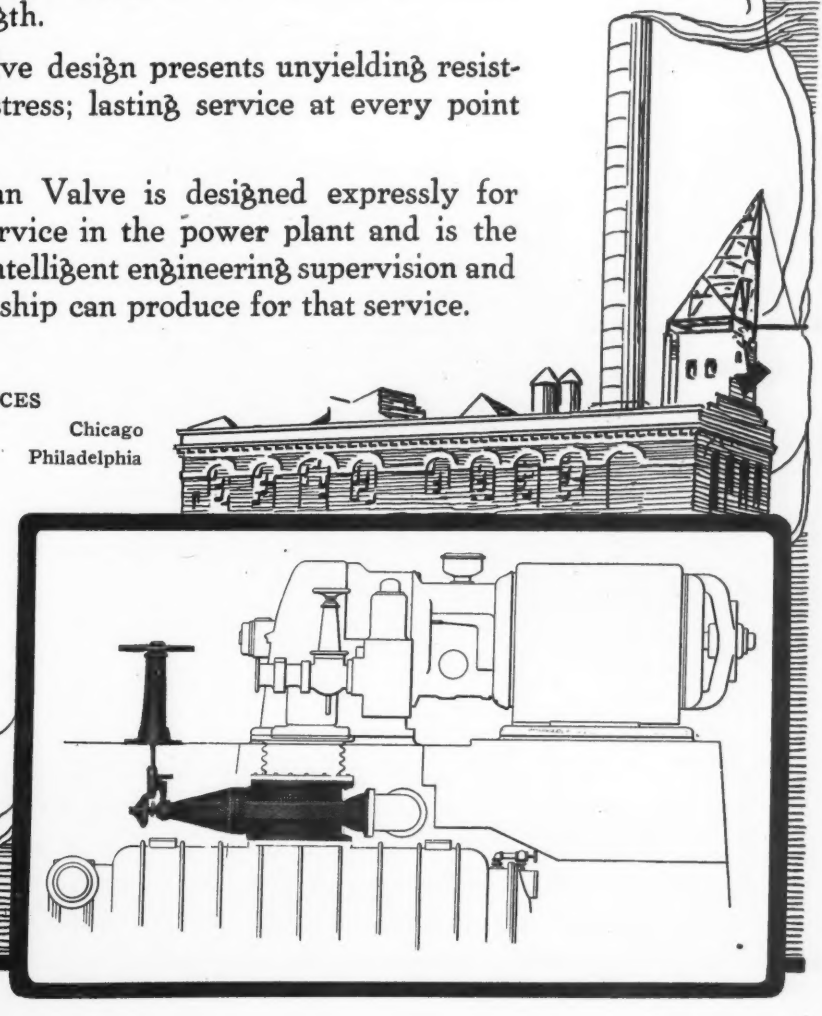
San Francisco Philadelphia



(Turbine Exhaust Valve No. 251BM. Note compact construction.)

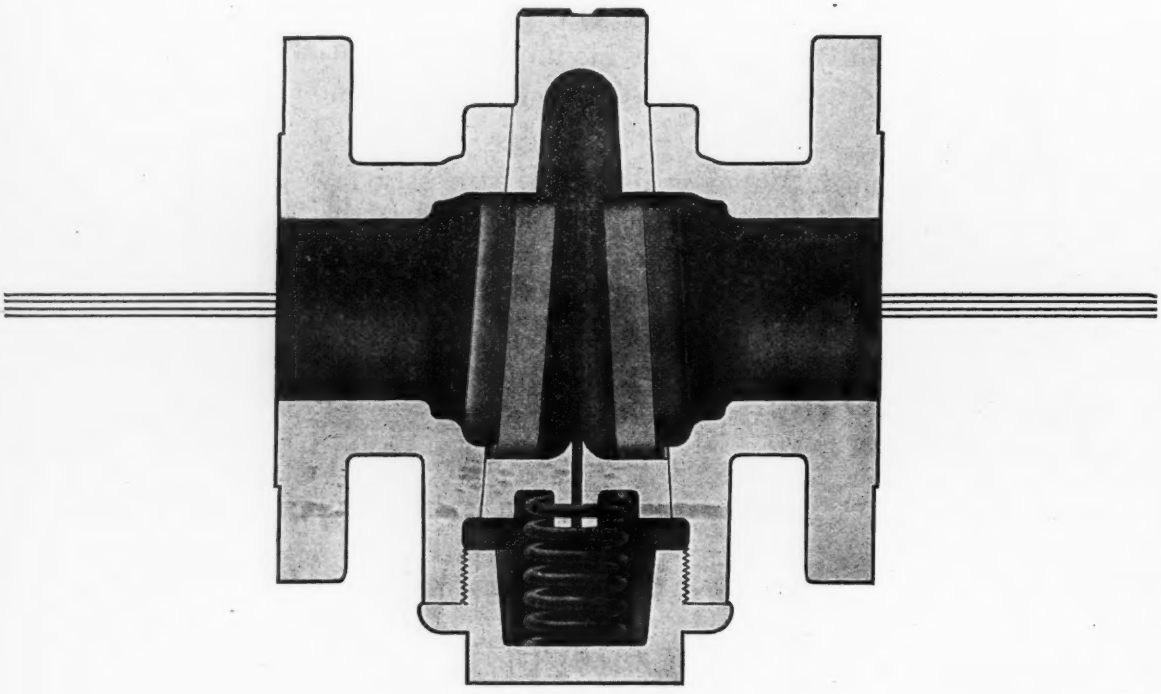
The Chapman Valve Mfg. Co.,
Indian Orchard, Mass., U.S.A.

CRANE

EXTRA HEAVY —— ALL IRON

Blow-off Cocks

with compensating spring complies with A.S.M.E. Boiler Code.



The Compensating Spring, which is located between the plug and the cap, automatically takes up wear and holds the plug securely in place at all times, thereby preventing the accumulation of scale, sediment, etc., which would tend to impair the ground bearing surfaces of the plug and body.

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FOUNDED BY R. T. CRANE, 1855

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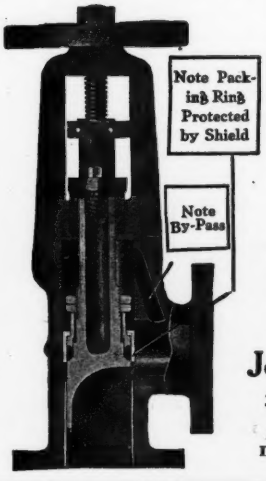
We are manufacturers of 20,000 articles—valves, pipe fittings, steam specialties, etc.—for all phases of power plant equipment, and are distributors of pipe, heating and plumbing materials.

10 Seconds that Save $10

400 B. t. u. is lost for every pound of water wasted through the blow-off according to one calculation recently made. Think how many pounds of hot water are blown down the sewer every time a blow-off valve sticks for a few seconds or few minutes! Then remember the

Balanced—Seatless—Automatic

Schiller Blow-Off Valve



closes in 10 seconds—no shock—gradual closing—it cannot stick.

And it closes **tight.** Scale or sediment cannot lodge.

Other points of Schiller Valve superiority shown in our literature. Write and find out why more than 5,000 firms are using them.

Write for descriptive Catalog

Joseph F. Schiller
314-320 South Lawrence Street
PHILADELPHIA, PENN.
Direct Representation Wanted in Open Territory

Lonergan

Pop Safety Valves

have just the right amount of lift to protect the boiler and valve seat. When firing under forced draft they relieve the boiler of all steam generated without any over pressure showing on the Boiler Gauge. We back this statement with our guarantee.

"Protected Spring" Pop Safety Valve, Model "B"

Model "B" for Water Tube Boilers has iron body, bronze mounted, encased spring, Lonergan Patent Double Eccentric Lifting Gear. Good for working presure up to 300 lb. Sizes 2", 2½", 3", 3½", 4", 4½", 5", and 6".

These valves will mean absolute safety at small cost. Write for 128-page catalogue.

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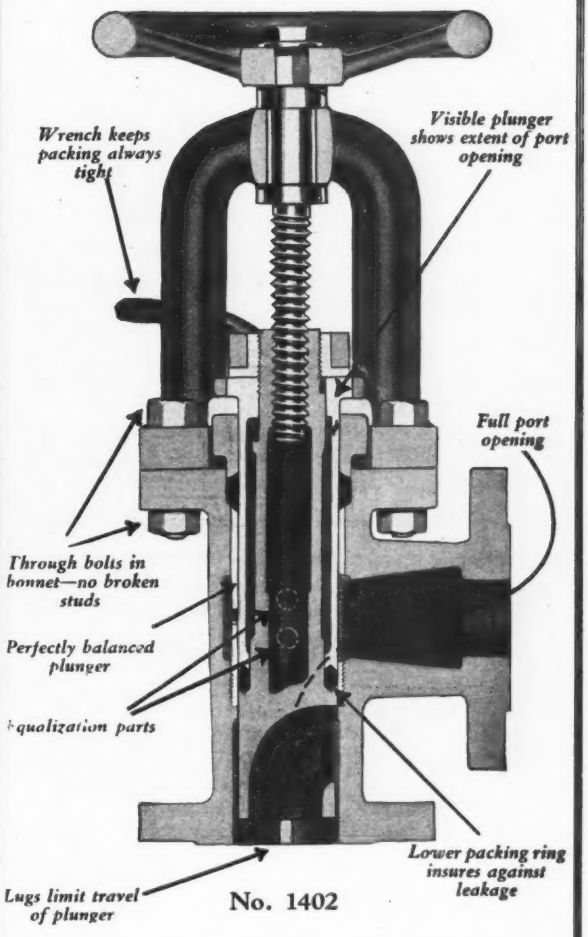
Philadelphia, Pa.
Established 1872

NELSON

Seatless Blow-Off Valve


Wrench keeps packing always tight
Visible plunger shows extent of port opening
Full port opening
Through bolts in bonnet—no broken studs
Perfectly balanced plunger
Equalization parts
Lower packing ring insures against leakage
Lugs limit travel of plunger

No. 1402

Two Thousand in Use Over Eight Years

Can be furnished in straightway or angle types, in bronze, iron or steel, with screwed or flanged ends.

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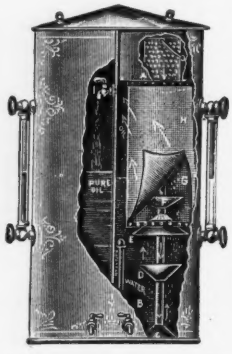
Save 65% of Your Oil Bills

To buy oil which is inferior just because the first cost is low is mighty poor economy, for such oil ruins machinery and lasts not half as long as good oil does. The high cost of the better grades is more than offset by the use of a

SIMS

OIL FILTER



It takes oil that has been used, **no matter how dirty** it has become, filters it, removing all grit or dirt, and returns it to you **as pure and clean as new.**

By this means at least 65% of your oil bills can be saved, as well as assuring better lubrication.

Others are saving this much and more—why not you? Write for our free bulletin and see how it's done.

The Sims Co.

2001 Holland Street

ERIE, PA.

FREE TRIAL

We'll **ship** and pay charges on a **Sims Oil Filter,** without obligation on your part, or you can get one direct from your supply house. Use it 30 days. If it doesn't fulfill our claims—if you are not fully satisfied—**ship** it back, at our expense.

On Sale in All Large Centers

What is Efficient Lubrication?

EFFICIENT lubrication is the positive application of the proper amount of clean, cool oil to the friction producing surfaces of bearings, cylinders and other working parts of machinery—automatically, constantly, unfailingly.

To do this means longer life for the machine, more precise and better work, increased production, fewer delays, smaller repair bills and a saving of the machine operator's time.

But efficient lubrication can be had **only** with correctly designed lubricating devices.

It is in this field that we have specialized for nearly half a century, producing scientific devices that best meet the individual requirements of all types of machinery.

Let our engineering department help you solve difficult lubrication problems. Efficient service at your disposal any time.

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DETROIT LUBRICATOR COMPANY
DETROIT, U. S. A.

60 Days' Free Trial Will Convince You of the Money Saved by

Airspring

COMPRESSED AIR GREASE CUPS

They will cut down your grease bills and improve your machinery. Write today for a trial cup and our booklet.

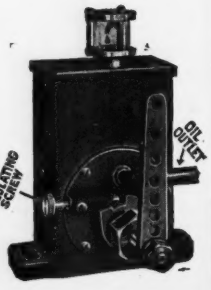
Hunter Pressed Steel Co.

450 Pierce St. Lansdale, Pa.

The Practical Sight Feed Oil Pump

is covered by a practical guarantee. Not only do we insure perfect material and workmanship—we guarantee it to feed any grade of cylinder oil, regularly and positively, regardless of the steam pressure or operating speed.

Such protection coupled with 30 to 50 per cent oil saving is real economy. Write for Catalogue P.



McCullough Mfg. Co.

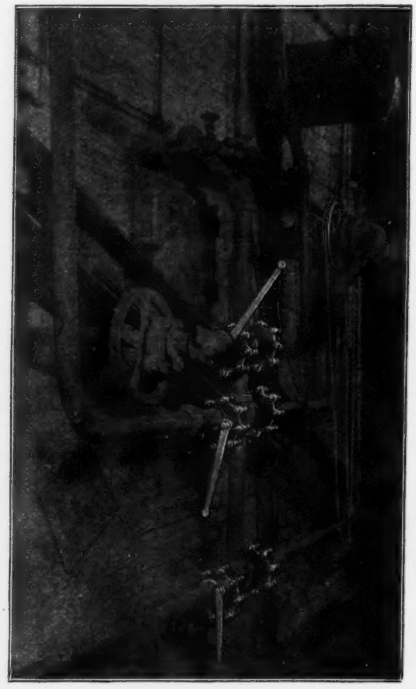
Minneapolis, Minn.

Sold and guaranteed by the leading supply houses.

The Everlasting Valve

For Soot Blower Installation

Delivers full head of steam immediately. Let us tell you about it.



Scully Steel & Iron Co., P. O Box No. 814, Chicago, Ill.

All Above Board

Every working part—and yet this Force-Feed equipment has proven its practicability for use in cement works, sand pits, flour mills, under a constant shower of dust-laden particles.

As proof of its advantages under these difficult lubricating conditions, the Hills-McCanna can be operated submerged in foreign substances without a trace of pollution in the oil line.

Simplicity of construction and the mechanical perfection of those few working parts are directly responsible for this efficiency.

Any adjustments can be easily and quickly made above board without removing complicated parts or interfering with the action of the remaining parts.

A positive, visible, ratchet driven, force-feed pump that can be depended upon to supply the desired amount of lubricant at the right place at the right time. Can you afford to be without this equipment?

Look for the Positive Ratchet Drive

HILLS-McCANNA CO.

Also Makers of Low Water Alarms; High Pressure Gauge Cocks; Boiler Compound Feeder; Boiler Inspectors' Test Pumps; Fusible Plugs; Brass, Bronze and Aluminum Castings.

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Own Your Own Truck Filling Station

Buy gasoline and oil in bulk, at quantity prices, and save on the cost of these two big items in trucking operation.

Keep them free from waste, dirt, evaporation and fire in Wayne Storage Tanks.

Get them to every truck in the fleet in the most time, labor and material saving way—with a Wayne Pump installed on your loading platform. Operated by a boy. Speedily and precisely measures and dispenses any quantity at a crank turn. Automatically computes the amounts used and gives you accurate fuel consumption records on each truck.

Wayne Equipment conserves the time of drivers and trucks for trucking. Your trucking efficiency goes up—your trucking costs go down. The investment is small and your savings are large.

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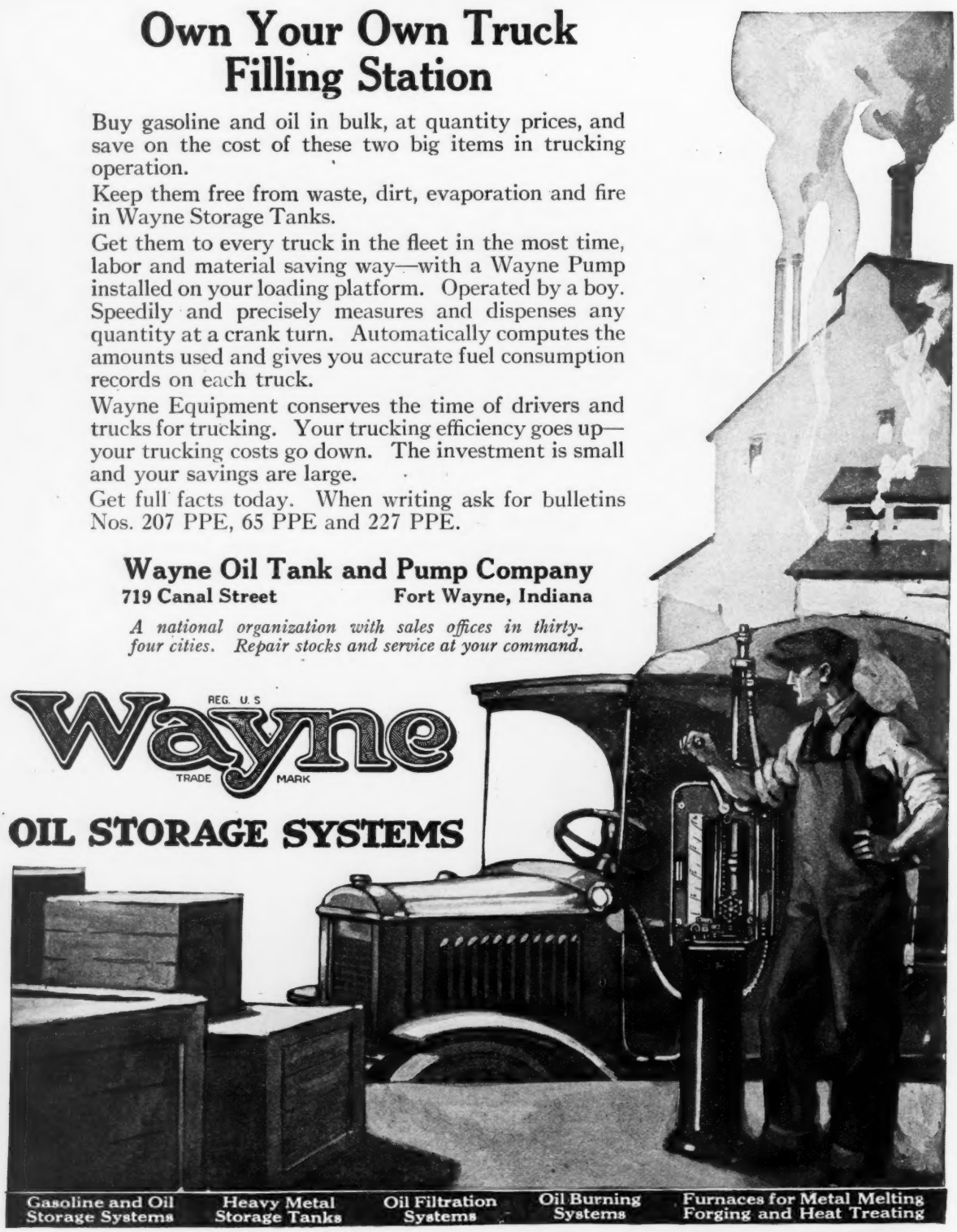
719 Canal Street **Fort Wayne, Indiana**

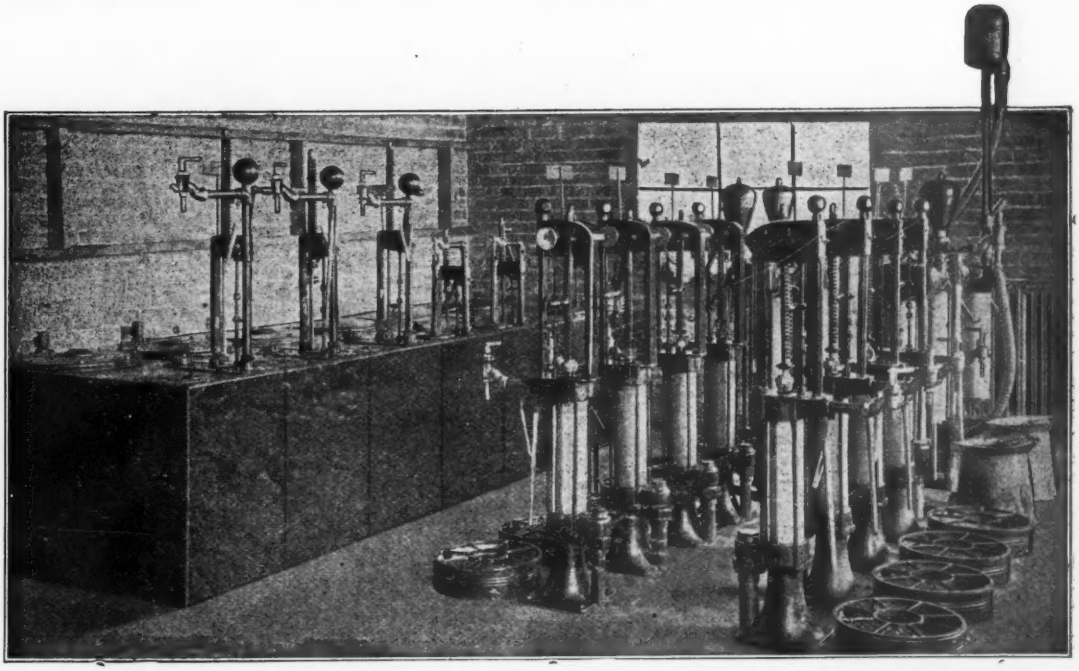
A national organization with sales offices in thirty-four cities. Repair stocks and service at your command.



REG. U. S. Wayne TRADE MARK

OIL STORAGE SYSTEMS

Gasoline and Oil Storage Systems | Heavy Metal Storage Tanks | Oil Filtration Systems | Oil Burning Systems | Furnaces for Metal Melting Forging and Heat Treating



HOW Infinitely Better

to "Bowserize" the Oil Department and Stop This Waste

Many factories have done away with leaky barrels; they have no waste from spillage in handling, nor losses from evaporation, and no dirty oil. Their oil departments are "BOWSER Equipped."

$6,483.30 Saved the First Year

that's the welcome story told by one prominent company after they installed a

BOWSER

Oil Storage System

To stop waste—to facilitate the handling of oil—to lessen danger, to overcome dirty oil, and TO SAVE MONEY is why thousands of companies have installed BOWSER Systems.

They are proud of this equipment and they should be. It means greater efficiency at a neat yearly saving in money.

No matter what your oil storage requirements are—no matter how much nor how little oil you use, we can show you a worth while saving over previous methods. Our engineers will quickly recommend an installation best suited to meet your requirements. Write today for particulars.

S. F. BOWSER & CO., Inc.

Fort Wayne, Ind.

S. F. Bowser & Company, Ltd.
Toronto

S. F. Bowser & Co., of Texas
Dallas

The Secret of Endurance

Power transmission belting must endure. It must withstand the destructive inroads of heat, moisture, dust, acid and the wear of constant use.

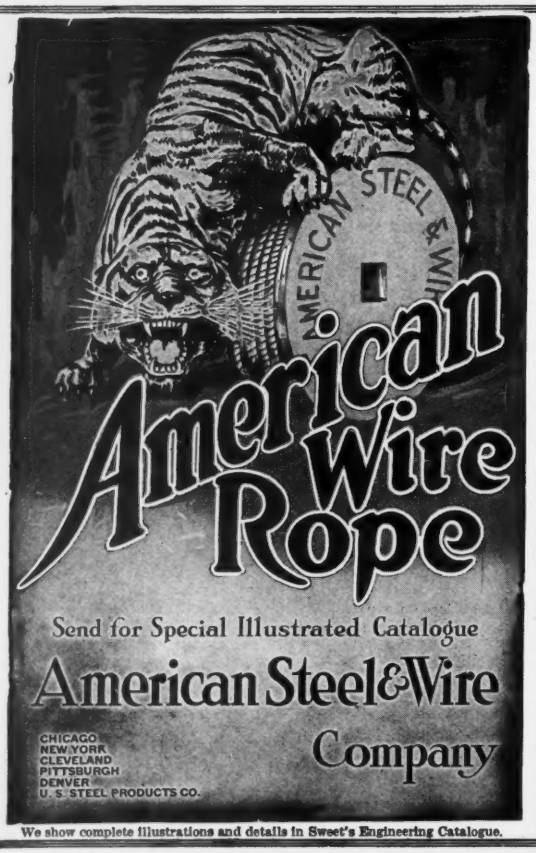
Camel's hair, famous for tensile strength, woven together with long staple cotton, makes practically an indestructible fabric. It is the secret of—

"CAMEL HAIR" BELTING

(A Daleway Product)

THE ROSSENDALE-REDDAWAY
Belting & Hose Co., Newark, N. J.

DALEWAY



American Wire Rope

Send for Special Illustrated Catalogue

American Steel & Wire Company

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NEW YORK
CLEVELAND
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DENVER
U. S. STEEL PRODUCTS CO.

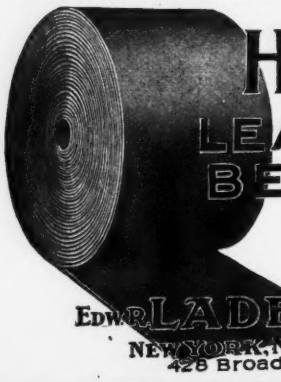
We show complete illustrations and details in Sweet's Engineering Catalogue.

DUXBAK BELTING
TRADE MARK

Chas. A. Schieren Company
ESTABLISHED 1868

Tanners and Belt Manufacturers
31 FERRY ST., NEW YORK

DUXBAK
Waterproof Leather Belting
ALWAYS LEADS IN TESTS OF
Quality, Endurance *and* Satisfactory Service



HOYT LEATHER BELTING
The Standard Since 1835

EDW. R. LADEW CO. INC.
NEW YORK, N.Y., U.S.A.
428 Broadway

(Illustration made from actual photograph of "China's conveyor" at work in Shansi.)

"Longlife" conducting coal in a modern plant.

In China - and just outside of Chicago

IN the province of Shansi, near Peking—reputed to have mines capable of providing fuel for the world for several thousand years — this coolie's best efforts are two hundred baskets a day.

Just outside of Chicago in a coke plant a Goodrich "LONGLIFE" Conveyor Belt, 1180 feet long, has just turned in its time card. It has hauled 2,442,913 tons of run of mine coal—in forty months—more than all the workmen in Shansi could produce in ten years,

—at .00198 per ton.

A haulage cost less than that of coolie labor, the cheapest in the world.

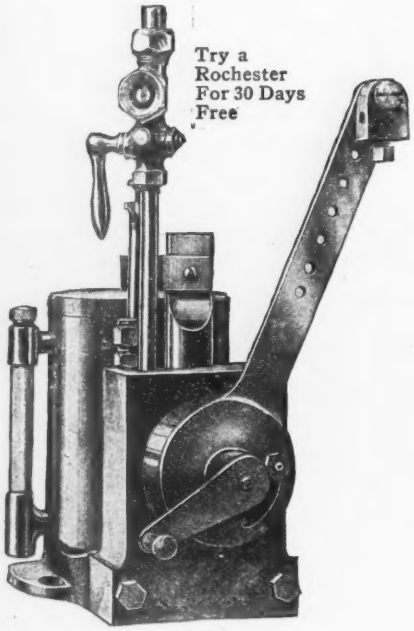
That's the belt for your plant—"LONGLIFE." Get in touch with our belt authorities—also write for catalog.

Goodrich "Longlife" Conveyor Belts

THE B. F. GOODRICH RUBBER COMPANY, Akron, Ohio

TRADE MARK

Best in the Long Run



Try a Rochester For 30 Days Free

SEE OUR CATALOGUE IN SWEET'S

Sixth Annual Edition, Page 589

Never Misses a Stroke

That is the reputation of the "Rochester" that challenges comparison. It is also one of the characteristics that makes possible oil savings of from 25 to 60 per cent in 20,000 plants.

No matter what the temperature pressure or vacuum the

ROCHESTER
CLUTCH DRIVE
AUTOMATIC LUBRICATOR

remains unaffected, delivering at all times the exact amount of oil called for.

Try a Rochester on your engine, pump or compressor for 30 days and see. You will find it simple, strong, easily repaired and wasteless. Catalogue T will tell you all about it. Write for your copy now.

Greene, Tweed & Co.

Sole Manufacturers

109 Duane Street, New York

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SPRACO

Cooling Ponds

are equipped with the

SPRACO CENTER JET NOZZLE. THE NOZZLE THAT SPRAYS AFTER ALL OTHERS HAVE CLOGGED.

Write for bulletin No. C-42

SPRAY ENGINEERING COMPANY

Manufacturers of Air Washers, Cooling Ponds, Paint Guns, Vaughan Flow Meters

Boston, Mass.

Condensing Apparatus

We specialize in the Design and Construction of

Surface Condensers
Jet and Barometric Condensers
Air Pumps
Centrifugal Pumps
Water Cooling Towers
Expansion Joints
Atmospheric Relief Valves
Low Pressure Exhaust Gate Valves

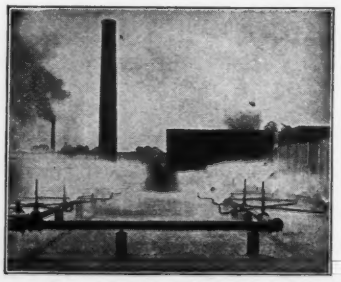
Let us assist you in solving your condensing problems.

C. H. WHEELER MANUFACTURING CO.
Philadelphia, Pa.

BRANCHES:

New York, Boston, Chicago, Pittsburgh, Charlotte, New Orleans, San Francisco, Seattle

Spray Cooling Systems

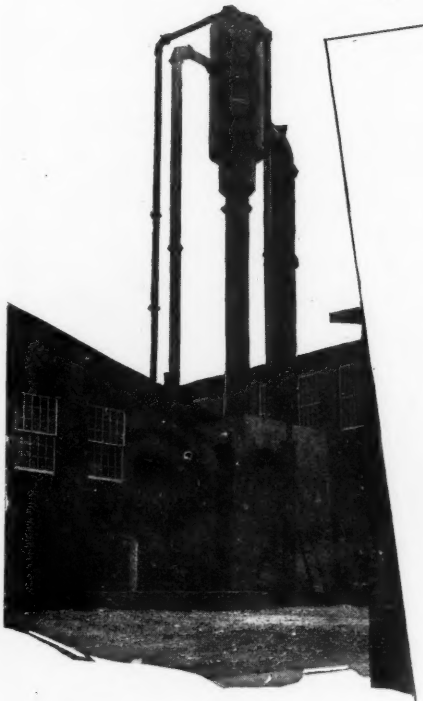


Wherever water for condensing purposes is scarce or procured only at very high temperatures, a SPRAY COOLING SYSTEM can solve your problem, increasing condensing emciency at the lowest expense. It is the most emcient, practical and reliable method of water cooling.

Write for bulletins.

THE STAR BRASS WORKS, Manufacturing Engineers
3100 Carroll Ave., CHICAGO, ILL.

"We would make the same installation again"



WILLINGHAM COTTON MILLS,
MANUFACTURERS OF
WIDE NUMBERED, HOSE AND BELTING DUCK.
SPECIALTIES IN HEAVY COTTON FABRICS.

MACON, GA. May 19,1920

Ingersoll-Rand Co.,
1102 Candler Bldg.,
Atlanta, Ga.

Gentlemen:

We are in receipt of your favor of May 18th in regard to the service we are getting out of the condensing equipment furnished us by your Company.

We can answer your letter very briefly.

Under the same circumstances, we would make the same installation again.

Yours truly,

WILLINGHAM COTTON MILLS.

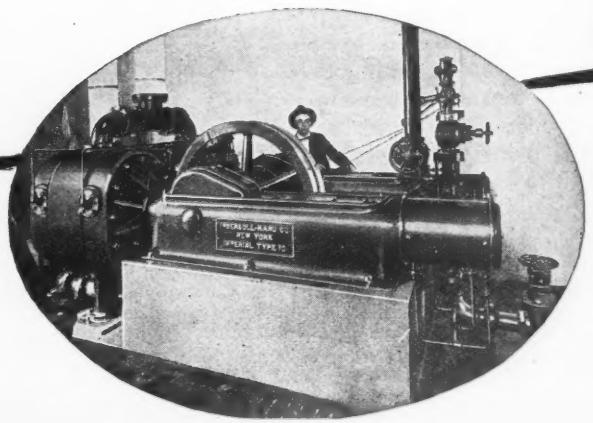
BEWJr/W

B. E. Willingham Jr.

The installation includes a No. 8 Ingersoll-Rand Barometric Condenser, a 12-in. stroke "Imperial" Vacuum Pump and a No. 10 "F V" Cameron Centrifugal Pump.

The condensing plant serves steam turbine handling 10,500 lb. of steam per hour with 85 deg. cooling water, maintaining a vacuum of 28 inches.

Send for Bulletin 9224



Ingersoll-Rand

General Offices; 11 Broadway, N. Y. C.

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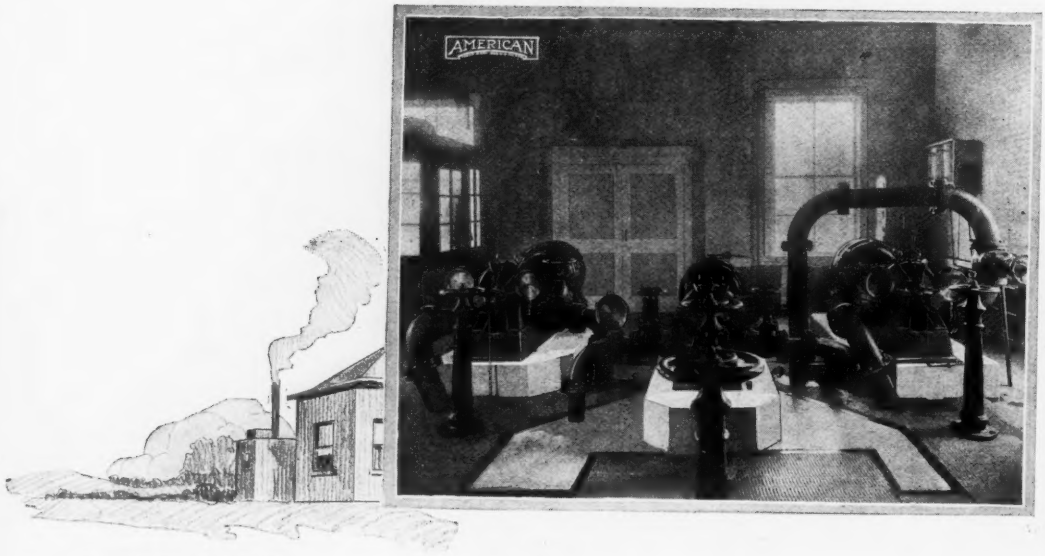
68-BC

Ingersoll-Rand

AMERICAN



Rosedale Pumping Station, Moose Jaw, Saskatchewan

The Rosedale Pumping Station installation consists of two 5" and one 4" American Pumps direct connected to 50 horsepower and 30 horsepower induction motors. The pumps work against a total discharge head of 155 feet—the 5" pump delivering an average of 1,350,000 Imperial gallons per 24 hours each, and the 4" pump handling an average of 860,000 Imperial gallons per 24 hours, pumping being from a reservoir supplied by a flow line.

A Pumping Station that Will Soon Pay for Itself

At Moose Jaw, Saskatchewan, the water supply used to be obtained from three or four widely separated pumping stations—each of which required constant attention.

The new Rosedale Pumping Station—an "American Pump" installation—requires the services of but one attendant—saves $5,000 a year in attendants' wages alone, as compared with the old system.

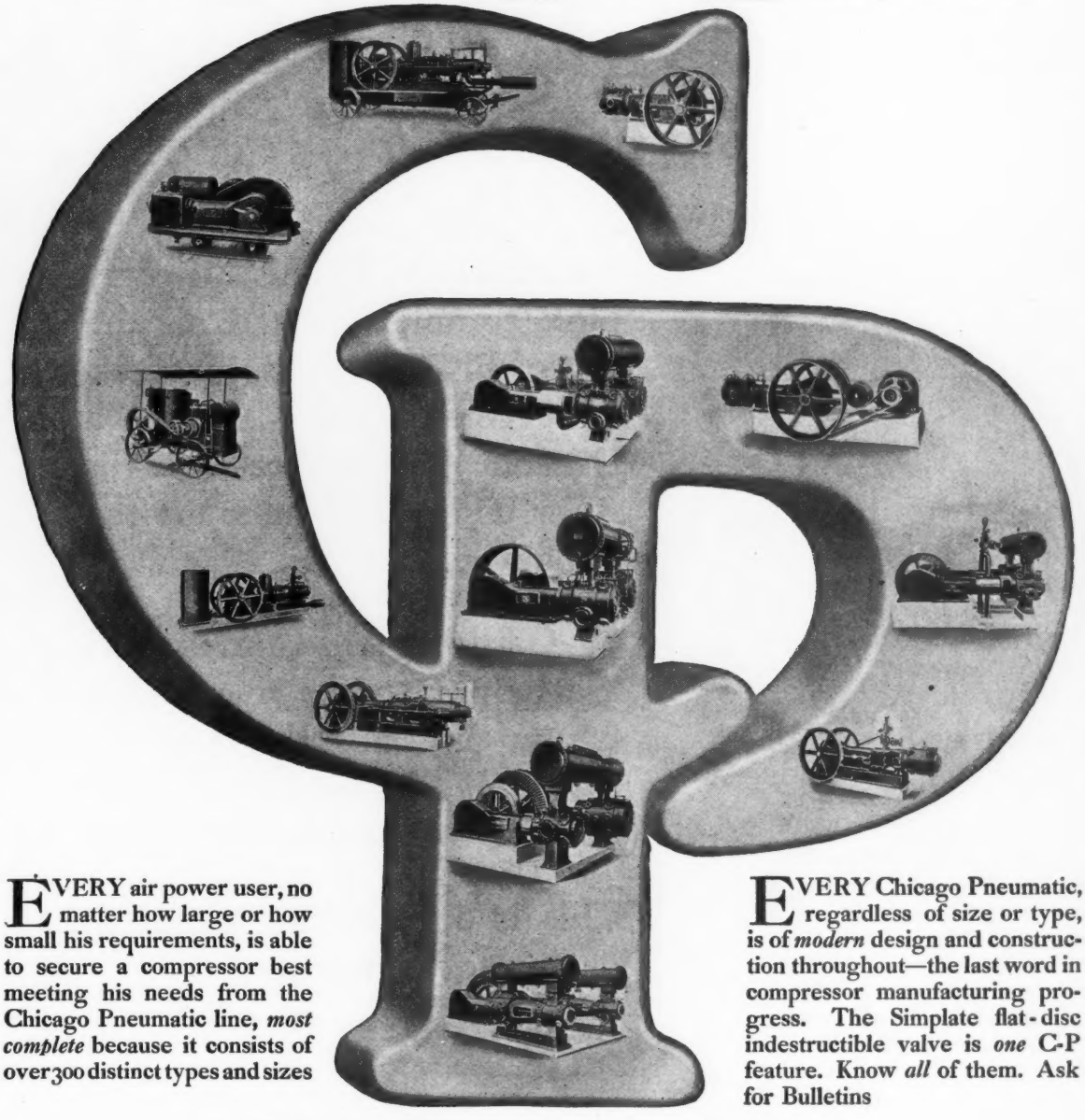
On the initial test, each of the American Pumps exceeded both the guaranteed efficiency and capacity. Fifty years of pump design has naturally resulted in a nicety of design that makes an "American" just a little better pump.

THE AMERICAN WELL WORKS

General Office and Works
AURORA, ILL.

Chicago Office
FIRST NATIONAL BANK BLDG.

300 sizes and types—all modern



EVERY air power user, no matter how large or how small his requirements, is able to secure a compressor best meeting his needs from the Chicago Pneumatic line, *most complete* because it consists of over 300 distinct types and sizes

EVERY Chicago Pneumatic, regardless of size or type, is of *modern* design and construction throughout—the last word in compressor manufacturing progress. The Simplate flat-disc indestructible valve is *one* C-P feature. Know *all* of them. Ask for Bulletins

Chicago Pneumatic Tool Company

Chicago Pneumatic Building • 6 East 44th Street • New York

*Sales and *Service Branches all over the World*

*Birmingham *Boston *Buffalo *Chicago *Cincinnati *Cleveland *Detroit *El Paso Erie *Franklin Houston Joplin *Los Angeles *Minneapolis *New Orleans *New York *Philadelphia *Pittsburgh *Portland Richmond Salt Lake City *San Francisco *Seattle *St. Louis Barcelona *Berlin Bombay Brussels Buenos Aires Cadiz Christiania *Fraserburgh Havana Honolulu Johannesburg Lisbon *London Madrid Milan *Montreal Osaka *Paris Seoul Tokyo Toronto Vancouver Winnipeg

C 83

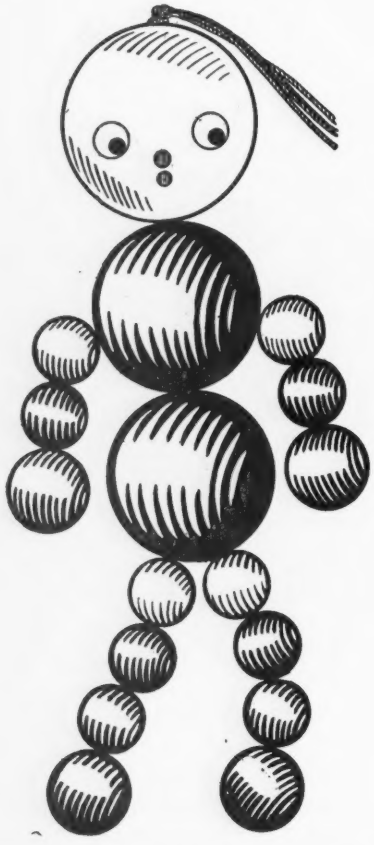
BOYER PNEUMATIC HAMMERS · · LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS · · VACUUM PUMPS · · PNEUMATIC HOISTS,
GIANT OIL AND GAS ENGINES ROCK DRILLS · · COAL DRILLS

CHICAGO PNEUMATIC

Depend upon *that Name*

GARDNER

Pumps-Governors-Compressors



TOMMY TINKER'S pretty pink complexion and all the rest of his paint, is sprayed on with compressed air from a Gardner Air Compressor. His sister Tillie is painted in the same way.

So Gardner Air Compressors are helping make the kiddies happy and also helping the Toy Tinkers to paint their toys quicker—cheaper—better.

This is only *one* of hundreds of uses for compressed air.

THIS IS TOMMY TINKER, a product of The Toy Tinkers of Evanston, Ill. Tommy and his sister Tillie are painted with compressed air from a Gardner Compressor.

The Superintendent says the Gardner Compressor gives entire satisfaction with a minimum of attention. Right now it is being operated continuously 24 hours every day.

No matter what your air requirements—there is a Gardner Compressor for your purpose. And every Gardner product is built up to the high quality standard established 62 years ago.

The name and trade mark of a complete line of Pumps, Governors and Compressors built right for 62 years.

GARDNER GOVERNOR COMPANY
Quincy, Illinois

Pumps --- Governors --- Compressors

Chicago	New York	Philadelphia	San Francisco	Los Angeles
Fisher Bldg.	Singer Bldg.	604 Arch St.	505 Howard St.	409 E. Third St.

Proof!

WESTERN UNION TELEGRAM

RECEIVED AT

23 CHD 15 COLLECT HERKIMER N.Y. 936 AM JUNE 19TH
MANISTEE IRON WORKS COMPANY
MANISTEE MICH.
ROTURBO CONDENSER ENTIRELY SATISFACTORY TWENTY SEVEN
AND ONE HALF TO TWENTY NINE INCH VACUUM.
MUNICIPAL COMMISSION 9:47 AM

WESTERN UNION TELEGRAM

RECEIVED AT

19DED 10 KALAMAZOO MICH 9:40 AM JUNE 19TH
MANISTEE IRON WORKS COMPANY
MANISTEE MICH
WE CONSIDER YOUR VACUUM ROTURBO CONDENSER ONE HUNDRED
PERCENT EFFICIENCY.
KALAMAZOO VEGETABLE PARCHMENT CO.

WESTERN UNION TELEGRAM

RECEIVED AT

32 D 25 COLLECT OWOSSO MICH. 4OSPM JUNE 21ST
MANISTEE IRON WORKS COMPANY
MANISTEE MICH.
OUR EXPERIENCE WITH ROTURBO CONDENSER VERY SATISFACTORY
MAINTAINING BETTER THAN TWENTY EIGHT INCHES CONSTANTLY
GLAD TO HAVE YOU REFER A POSSIBLE CUSTOMER TO US.
OWOSSO MFG. CO.

WESTERN UNION TELEGRAM

RECEIVED AT

30 CHD 20 COLLECT HOLLAND MICH 9:16 AM JUNE 19TH
MANISTEE IRON WORKS COMPANY
MANISTEE MICH
CONDENSER IS WORKING SATISFACTORILY TWENTY SEVEN AND
NINE TENTHS INCHES VACUUM AT TWENTY NINE AND ONE HALF
INCH BAROMETER
BOARD OF PUBLIC WORKS CO 11:14AM

WESTERN UNION TELEGRAM

RECEIVED AT

17 CHCU 30 COLLECT
ELIZABETH NJ 9:36A JUNE 19 1920
MANISTEE IRON WORKS COMPANY
MANISTEE MICH.
ROTURBO CONDENSER TESTING WATER AT SIXTY SEVEN DEGREES
FARRENHEIT TWELVE FOOT THROUGH HUNDRED SEVENTY FIVE OF
EIGHT INCH PIPE WITH FOUR NINETY DEGREES ELBOWS MAINTAIN
VACUUM TWENTY SEVEN AND HALF INCHES UNIT DOING ALL THAT
WAS CLAIMED FOR IT WE ARE SATISFIED WE USE GOOD JUDGE-
MENT WHEN INSTALLING SAME
BITTER LBR. CO. 9:30 AM

WESTERN UNION TELEGRAM

RECEIVED AT

58CH JO 18 COLLECT
PETOSKEY MICH. 5:12 PM JUNE 18 1920
MANISTEE IRON WORKS COMPANY
MANISTEE MICH.
OPERATION SATISFACTORY VACUUM UP TO 27 INCHES VERY RELIABLE
NO TROUBLE OR REPAIRS SINCE INSTALLED
PETOSKEY WATER LIGHT DEPT.
5:46 PM

Manistee Iron Works Co.
Manistee Michigan
Manufacturers of the ROTURBO Condenser.

EVACTOR

Trade Mark

A Distinctive Air Pump

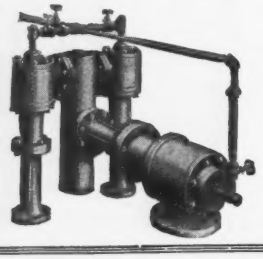
First, because of its three separate and distinct capacities which permit great flexibility in operation, and next the absence of any moving parts. This makes it most economical in upkeep and eliminates all lubricating expense.

Only a small space is needed for its installation which requires very little expense.

Simplest construction—no reciprocating or rotating elements.

On either Surface, Jet or Barometric Condensers and wherever high vacuum is desired, reliable and efficient service results. Takes the place of the Reciprocating Dry Vacuum or Hydraulic type of air pump.

Bulletin N will acquaint you with the advantages of the Evactor. Write for it.



Croll-Reynolds Co., Inc.
95 Liberty Street
New York

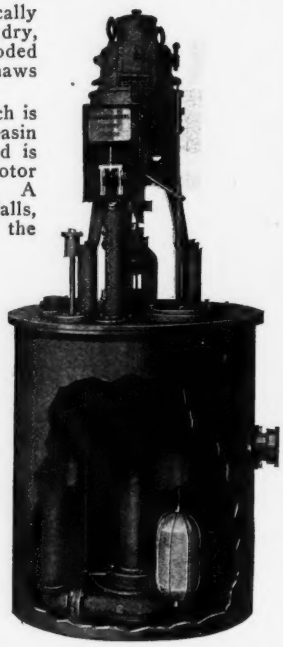
YEOMANS
Electric Bilge Pumps

are made to automatically keep sub-basements dry, which usually become flooded when heavy rains or thaws overtax the sewers.

It is a small pump which is suspended in the catch basin from the basin cover and is operated by an electric motor which is mounted on it. A copper float rises and falls, according to the level of the contents of the basin—a movement which stops and starts the motor.

Special devices assure perfect lubrication and prevent shaft corrosion.

Bulletin No. B-3000 fully illustrates and describes our pump. It's free. Why not write for it?



Yeomans Bros. Company
1432 Dayton St.
CHICAGO
Agents in Principal Cities

Voorhees Rub-Steel Valves

BETTER THAN METAL/RUBBER BECAUSE OF THE RUBBER/METAL

"Get 'em in Your Pump"—

Until you do you will **never** know **real** valve action!

BECAUSE:—Neither the all-rubber valve with its tendency to dish and blow through under pressure, nor the all-metal valve with excessive weight, can meet today's demands for the good valve service so necessary for efficient and economical pump operation. VOORHEES RUB-STEEL VALVES unite the virtues and eliminate the objectionable features of both.

As compared with all-rubber it is simply the dishing, warping, chipping and crumbling article against a continually true, level, pressure-defying disc. As against metal, a quiet, flexible but substantial valve, requiring no periodical facing.

Beside all other combinations—well, try them yourself.

Free sample sent upon request

Voorhees Rubber Mfg. Co.
JERSEY CITY, NEW JERSEY
New York Office: 30 Reade Street

DEAN BROS. STEAM PUMP WORKS

The Valve Movement

of DEAN BROS. DURABLE DUPLEX STEAM PUMP is the most important improvement that has been made on a duplex steam pump for twenty-five years. Send for Catalogue 106.

DEAN BROS. STEAM PUMP WORKS. INDIANAPOLIS.

New York Sales Office: 141 Broadway

Pumps or Blowers Bearing This Trademark Will Give 100% Service

ROOTS

Since 1859, over 61 years, Roots Pumps and Blowers have been giving superior service under most severe working conditions.

Get complete facts. Consult our engineers and study our catalogues. No obligation on your part.

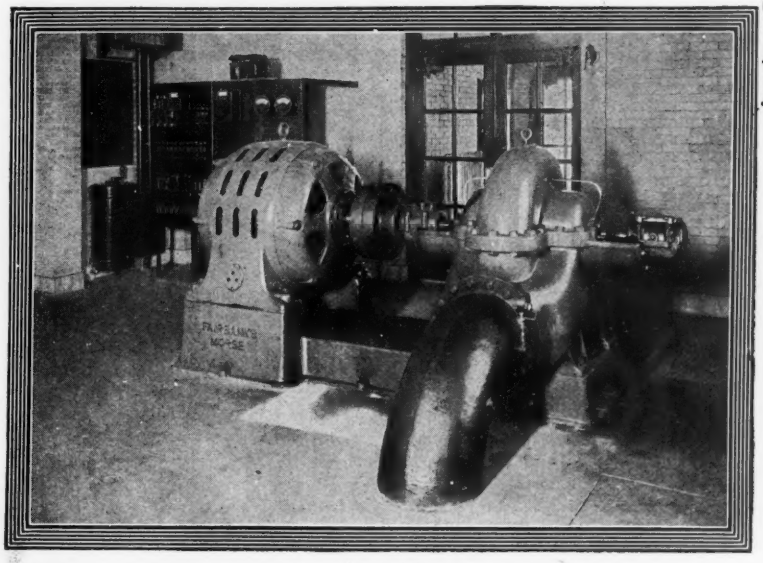
The P. H. & F. M. ROOTS CO.
Dept. 18
Connersville, Indiana.
Chicago Office
128 S. Michigan Ave.
New York Office
Room 808—120 Liberty St.

Blowers for Cupolas, Furnaces, Smelters, Agitation of Liquids, Pneumatic Conveyors, etc.

Gas Pumps for By-Product Coke Plants, Gas Works, Handling Chlorine, Sulphur Dioxide, etc.

Rotary Pumps for Wash Oils, Tar, Asphalt, Syrups, Crude Oil, Milk, Molasses, etc

Vacuum Pumps for Paper Mills, Sugar Mills, Vacuum Filtration, Priming Centrifugal Pumps, Heating Systems, etc.



Omaha uses this Fairbanks-Morse Motor Driven Pump

The City of Omaha installed a 200 H. P. slip ring ball bearing motor and a 15" split Case Centrifugal Pump in its Metropolitan Water District.

Fairbanks-Morse Ball Bearing Motors have solid rotor winding—end rings cast on solid copper bars—a one piece jointless structure that cannot spark, flash, or arc.

Ball bearings packed in grease eliminate oil slop—reduce friction.

Fairbanks - Morse pumps have made good on countless jobs. They are dependable and durable.

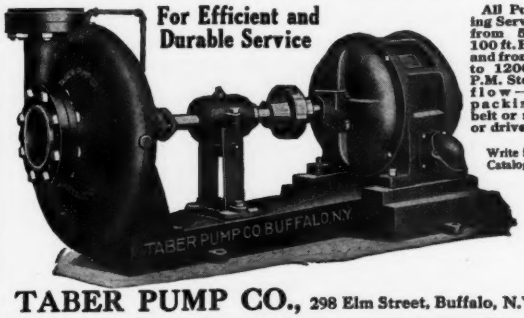
Fairbanks, Morse & Co.
MANUFACTURERS CHICAGO
The Canadian Fairbanks-Morse Co., Limited—Montreal

FAIRBANKS-MORSE QUALITY F M 100%

Oil Engines - Pumps - Electric Motors and Generators - Fairbanks Scales - Railway Appliances - Farm Power Machinery

TABER PUMPS

For Efficient and Durable Service



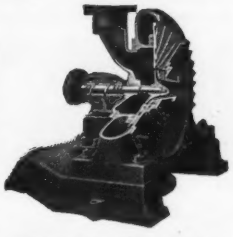
All Pumping Services from 5 to 100 ft. Head and from 30 to 1200 G. P.M. Steady flow—no packing—belt or motor drive.

Write for Catalogue

TABER PUMP CO., 298 Elm Street, Buffalo, N.Y.

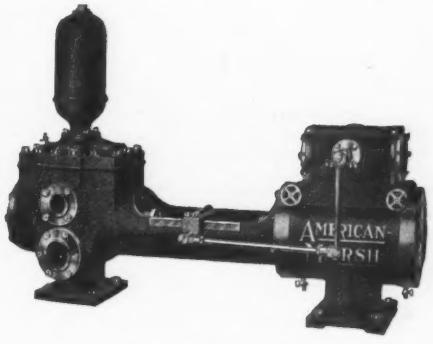
Wheeler Condensing Equipment

Wheeler Turbo-Air Pumps—motor, belt or turbine driven.
Wheeler Steam Jet Air Pumps, with inter-condenser. The most efficient steam jet pump made.
Wheeler Rotative Dry Vacuum Pumps.
Wheeler-Edwards Combined Vacuum and Condensate Pumps.
Wheeler High Vacuum Condensers—all sizes—all kinds.
Wheeler Centrifugal Pumps for all services.
Wheeler Cooling Towers.
Wheeler Evaporators — single and multiple effect.
Seamless drawn brass, copper and special mixture tubes.
Write for Bulletin on the phase of condensing in which you are most interested.



Wheeler Condenser & Engineering Co.
CARTERET, N. J.

American-Marsh Pumps



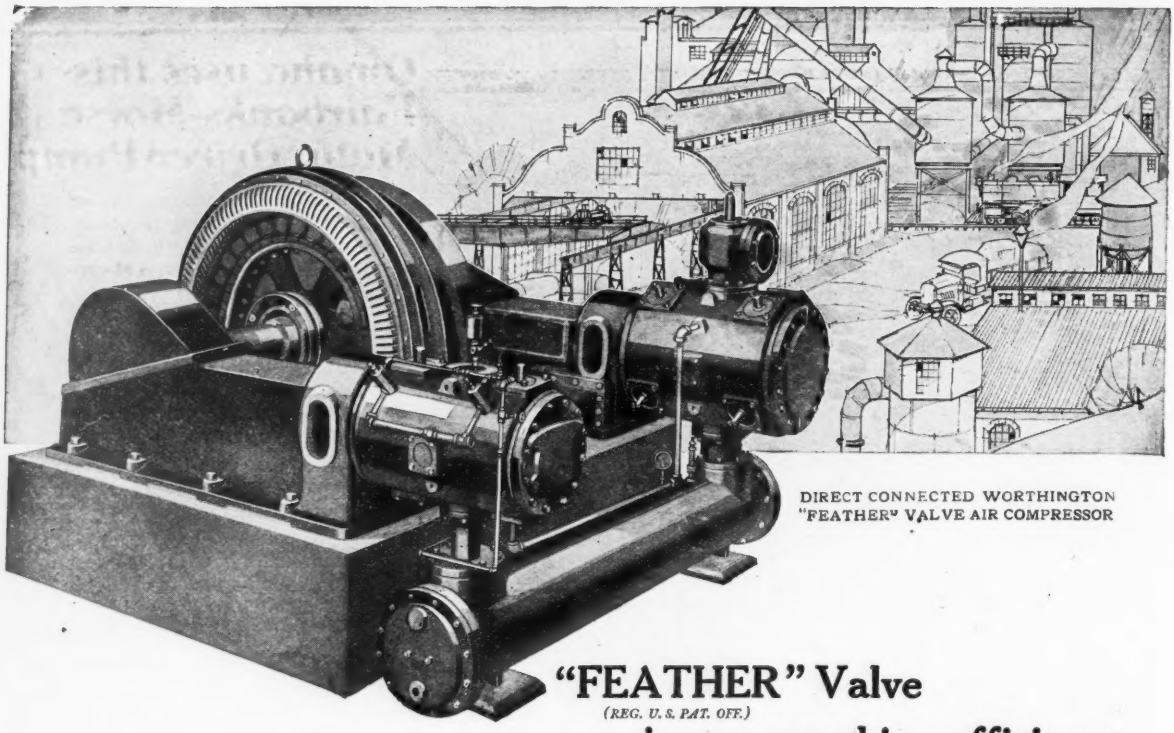
Over 155,000 in Successful Operation

American-Marsh Pumps combine extreme simplicity with an unusually low steam consumption, and are the result of over thirty years' experience in the manufacture of high grade pumping machinery. The line includes:

Vacuum Pumps	Power Pumps
Centrifugal Pumps	Deep Well Engines
Air Compressors	Jet Condensers

Complete catalog furnished promptly upon request. Ask for it.

American Steam Pump Company
Battle Creek, Mich.



DIRECT CONNECTED WORTHINGTON "FEATHER" VALVE AIR COMPRESSOR

"FEATHER" Valve
(REG. U. S. PAT. OFF.)
insures machine efficiency

AS MR. NAT EMERSON, of the Standard Carbonic Co., writes to his Cincinnati office concerning the original "FEATHER" Valve equipment in the first "FEATHER" Valve Compressor turned out by Worthington. "... These have been in service about five years and two months and you will note are still in good shape."

"This Compressor, as you know, has been very satisfactory and was instrumental in selling a similar one to the Peabody Hotel of this city, and several to the I. C. shops here in Memphis."

All Worthington Gas and Air Compressors, Snow type Oil and Gas Engines and the mammoth Worthington All American designed Marine Oil Engine are "FEATHER" Valve equipped—very pertinent reason why Worthington apparatus has proved so successfully efficient.

Other Worthington Products:
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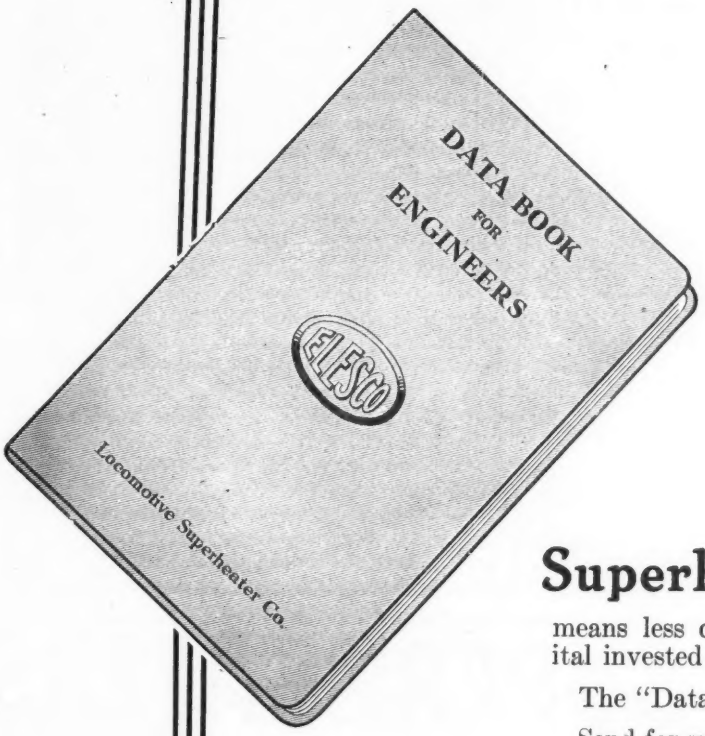

Superheated Steam

means less coal, less labor and less capital invested in equipment.

The "Data Book" tells why.

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The Data Book is complete with information and tables on superheated steam and kindred subjects. All the data is essential for everyday problems.

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and, tho' there've been trials and tribulations, we're still on a pretty even keel with all sails set for the **port ahead.**

Mrs. Wiggs of the Cabbage Patch said—'there's heap more in smilin' than in sighin',

and Mrs. Wiggs was *right*—quite right.

Now 'all together'—with a **Most Merry Christmas and A Happy New Year**

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Water Heating Engineers
Manufacturers of Heaters
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Conserves Coal

—While Increasing Heating Capacity and Life of Boilers.

How? By utilizing exhaust steam—ordinarily a dead waste—to heat boiler feed water, taking the financial and physical strain off the coal pile and boiler.

The "National" insures—
—Maximum heat extraction.
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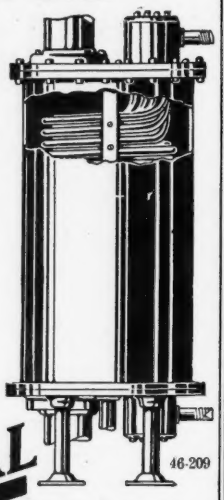

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A necessity for turbine protection, engine cylinder economy, and utilization of superheat for all its benefits

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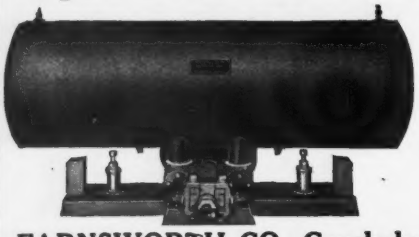

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Cuts Coal Costs More Than 12%

It has been accurately computed that by raising the temperature of the feed water a yearly fuel saving amounting to 12.73 per cent may be made. The

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not only makes this coal saving possible but it adds time and labor saving. Scale, corrosion, split tubes, leaky heads and expansion strains are eliminated by use of correct metals and scientific construction.

The small, spirally corrugated tubes of pure copper cause the water to swirl with scouring motion that prevents deposits. Almost instantaneous heating results from this intimate contact with the hot tube walls.

The floating tube head is split horizontally so that each half moves independently, thus compensating for unequal tube expansion. Shells, water chambers and heads are made of cast iron.

Capacities from 200 to 200,000 gallons per hour. Write for our special bulletin. It points the way to big economies.

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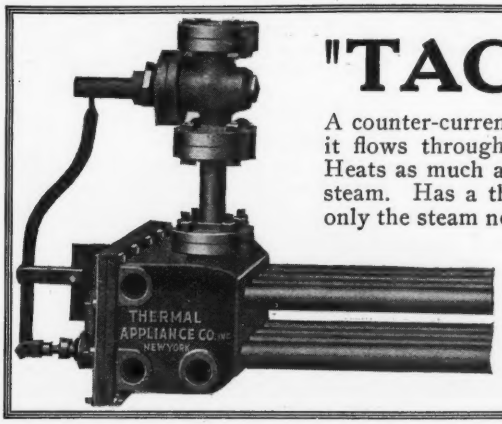

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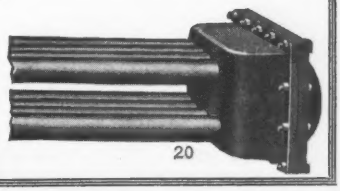

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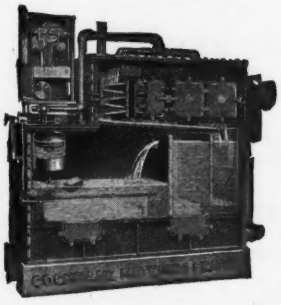

The Utilization OF Exhaust Steam

offers one of the greatest economies possible in steam plants. Sometimes 50% of the fuel can be saved in this manner.

Our Engineering Department would be glad to confer with you regarding possible ways of increasing economy and saving fuel in your plant.

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Surface Barometric and Jet Condensing Equipments for Power Plants.
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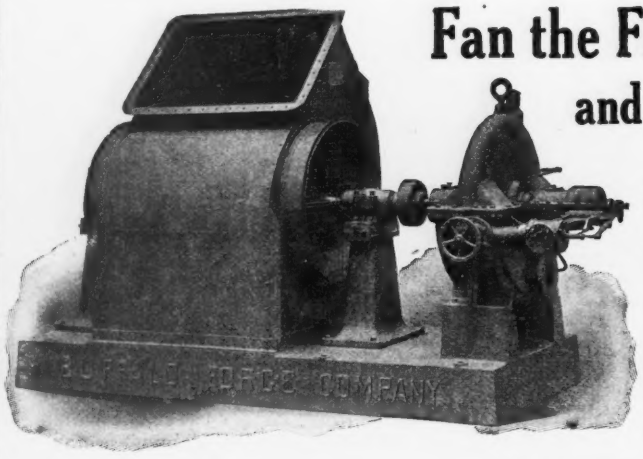

Fan the Flame Producing Power
and it will make more power

As our frugal ancestors used the bellows on the fire to urge more active heat from the smoldering back log, so hundreds of power plants today are applying this same economical principle in a bigger way by installing

TURBO CONOIDAL FANS

to save more heat.

More power from less coal is sure to result if you give your boiler the right amount of air at the right pressure. Poor fuel can be burned with good results with the aid of a **Buffalo Turbo Conoidal Fan.**

Buffalo Fans are compact, rugged and may be controlled to meet the varying demands of light loads and peak loads efficiently.

If you are interested in improving combustion to save fuel, write for Catalog 420-64. It will prove valuable.

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FOR EVERY LIFTING SERVICE

To meet various handling requirements many types and capacities of Shepard Electric Cranes and Hoists have been developed, including 1 and 2-Motor Floor Controlled Hoists ranging in capacities from ½ to 10 tons.

Hoists for stationary service and for electrifying the hoist motion of hand cranes, are built in capacities up to 20 tons—Traveling Cranes up to 30 tons.

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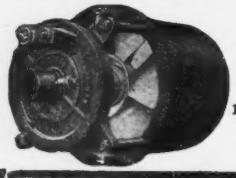

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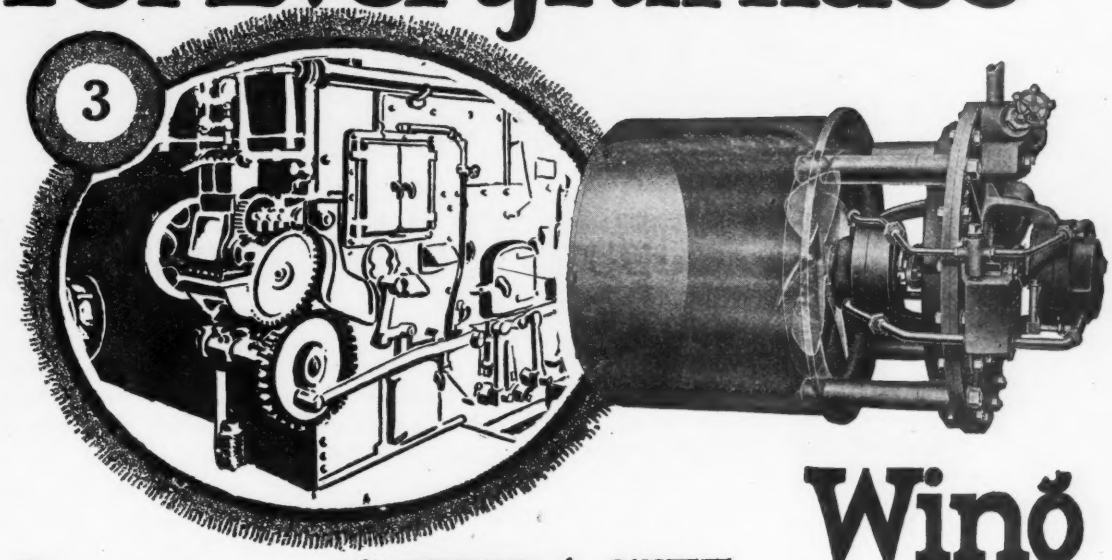
Plants in Pennsylvania, Ohio, Kentucky, Indiana and Alabama

For Every Fuel For Every Furnace



Burning-ANTHRACITE on V-Type Stokers

Although the V-Type Stoker was designed for bituminous coal, excellent results are being produced burning anthracite mixtures when these stokers are equipped with Wing Turbine Blowers. With fuel containing as much as 67% of barley coal, high rates of combustion are obtained and high boiler capacity developed. With bituminous dear and hard to get, continuous operation is nevertheless assured with anthracite by using Wing Blowers.

Of course, with straight bituminous, Wing Blowers are an equally profitable investment, developing boiler horsepower 'way beyond what is possible under natural draft limitations, and assuring ample steam at all times.

Wing Turbine Blower

The Original In 1905 **The Standard Since 1905**

The Wing is easily installed under V-Type furnaces, in one of several ways, employing either one blower per boiler, or two. The installation may be made from the side, or rear, or from the front, as desired.

The automatic lubrication of the large ball bearings by means of positively-filtered oil gives the blower the longest life with the minimum of repairs or attention. The patented Expanded Fan Casing makes for economical and quiet operation.

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Manufacturers of Blowers, Damper Regulators, Ventilating Fans, Pressure Blowers, Vacuum Pumps and Small Turbines

Wing - the Standard Forced Draft

Stop Plant Waste
that Pull Down Pr

Coppus Turbo Blowers Cha ng

" 'Cost plus' was good enough policy perhaps for war times, but it's a mighty poor policy for peace times," said the General Manager to the Chief Engineer, "and 'Cost Plus' seems to be all we are getting nowadays around this plant and in every other business, so far as I can learn."

"Well, I'll tell you how we can take some of the 'plus' out of the costs in my department," replied the Chief.

"Shoot," said the General Manager.

"It's like this," went on the Chief. "Here we are up against poor coal and sometimes no coal, but at all times higher priced coal."

"Yes, I know that," said the General Manager. "That's why I call these the times of 'Cost Plus.' No matter how I figure costs there are constantly unforeseen costs that we have to pay which puts our profits on the blink."

"But I can stop this in my department if you will give me what I want," said the Chief, "and it will cost you mighty little to do it, too.

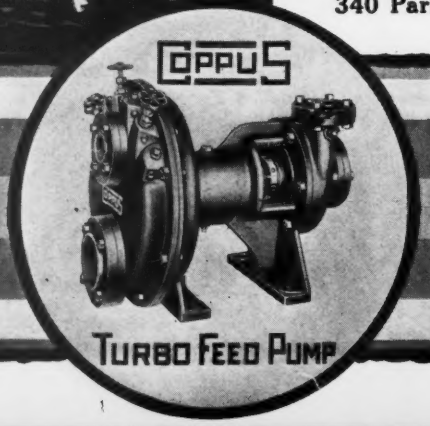
"You see, in steam generation it isn't the **price** you pay for coal, or the **kind** of coal, or the **cost** of labor, or any other one item that determines the economy of the plant, but the final basis is the **cost per pound of steam.**

"Now take our coal alone. It's not the number of B. t. u. 's

Coppus Engineering & Equipment Co.

Manufacturers of Coppus Turbo Blowers, Coppus Turbo Feed Pumps and Coppus Power Turbines.

340 Park Avenue **Worcester, Mass.**



REGIS
COP
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nge Cost Plus to Cost Minus

to the ton of coal, but the number of pounds of steam we get out of a ton that tells the story.

"And that is determined more than in any other way by the **draft** used in burning the coal.

"So if you will give me the proper **draft**—which is nothing but air in motion—I will guarantee to give you the most pounds of steam from **any** coal—high grade, low grade, culm, screenings, or what not."

"Well, tell me how I can give you this draft you are talking about. Sounds like hot air to me."

"It's simple enough," answered the Chief. "This thing has all been worked out and reduced to a science. Put **Coppus Turbo Blowers** under your boilers. Hundreds of plants are using them. Personally I like the **Coppus** best because I know it is built right to stand up to its work for years without repairs and because I know what it is doing in other plants.

"Send to their Engineering Department and you will get absolute proof that they can save 10 to 25 per cent on our fuel bills and increase boiler capacity, too."

"That sounds good to me," said the General Manager. "Let's write now and start changing this 'Cost Plus' into 'Cost Minus'."

Catalogue on request.

Coppus Engineering & Equipment Co.

Manufacturers of Coppus Turbo Blowers, Coppus Turbo Feed Pumps and Coppus Power Turbines.

340 Park Avenue **Worcester, Mass.**

We're lined Up to Fight the Cost of Handling Coal and Ashes

Consult us without obligation and we will show you how you can save time, labor and money with a

Gifford-Wood Wagon Loader

WRITE TODAY

G.-W. Loaders with Feeder Attachment

Mechanical Handling in all lines of Industry

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MAIN OFFICE AND WORKS Hudson, N. Y. NEW YORK, BUFFALO BOSTON, CHICAGO

Carling Turbine Blowers

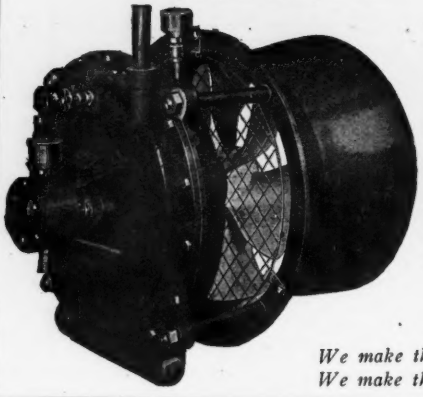
For burning the lowest grades of coal successfully, getting all the heat value from the fuel. For positive draft with Automatic Control and steady steam pressure. For obtaining the ultimate capacity from the boiler.

Carling Turbine Blowers are low in first cost, easy to install and make a quick return on the investment. We will be pleased to show you why it pays to use Carling products.

Write today. Try at our expense.

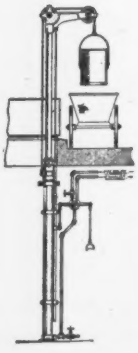
CARLING TURBINE BLOWER CO.

Engineers and Manufacturers
WORCESTER, MASS.



Turbine Undergrate Blowers, Centrifugal Blowers and Exhausters, Small Power Turbines.

We make them safe.
We make them strong.



THE DEAN ASH HOISTS

Will lift a can of ashes, or other material, to the street level quickly, by means of air, steam or hydraulic pressure.

Operating valve simple in construction. Piston made of polished steel tubing; cylinder is of lap-welded pipe. Compact construction; nothing to get out of order. Automatic in action to retard piston speed and stop at limits of piston stroke without shock. Durable and efficient.

Complete information upon request. Our engineering department is at your service.

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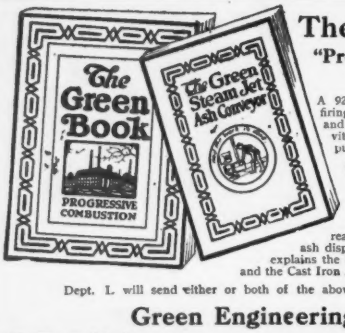

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"Progressive Combustion"

A 92 page book of facts on stoker firing. Acknowledged the soundest and most sensible treatment of this vital power plant problem ever published.

Green Steam Jet Ash Conveyor Booklet

32 pages of easy reading that reaches straight to the heart of the ash disposal question. Illustrates and explains the Green Steam Jet Ash Conveyor and the Cast Iron Ash Tank.

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Green Engineering Co.

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Chain Grate Stokers, Steam Jet Ash Conveyors, Cast Iron Ash Tanks, Sealflex Arches, Pressure Waterbacks.

Girtanner Standardized Steam Ash Conveyor

Removes ashes mechanically from boiler room to ash bin, over-head hopper or car at average cost of 15 cents a ton. Eliminates ash wheelers. Pays for itself in less than a year in wages saved.

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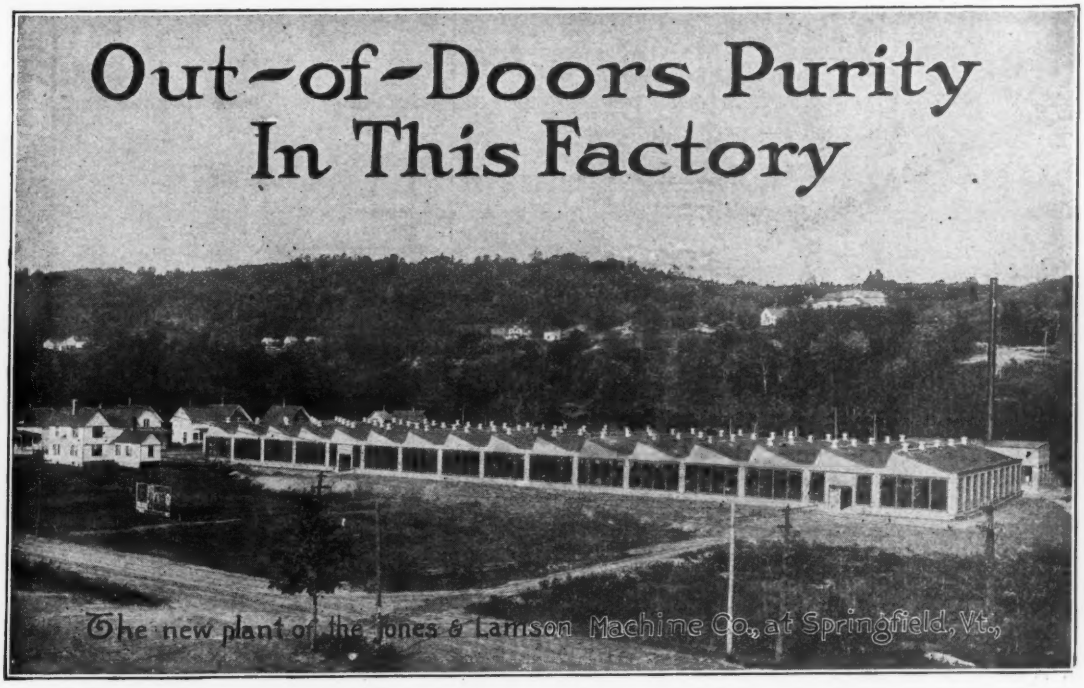
Out-of-Doors Purity In This Factory



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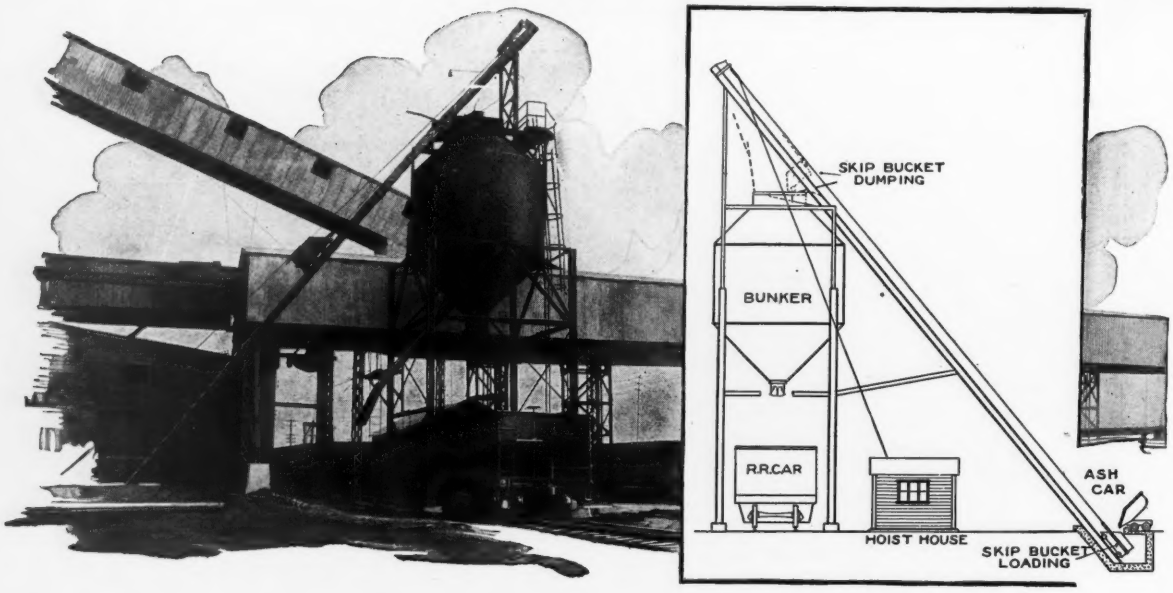

A More Efficient and Economical Method of Handling Ashes

If you are endeavoring to cut down overhead and production costs, give some consideration to your boiler rooms. Your present method of handling ashes and coal may be contributing to your production costs in unbelievable proportions. Ordinarily this phase of the problem is overlooked, yet it may represent a constant drain on profits. Investigate the method of ash handling now employed in your plant. It is a fact, easily proved, that whatever methods you now employ have some inefficient and expensive disadvantages which the Beaumont Skip Hoist System overcomes.

With the Beaumont Skip Hoist, ash handling becomes efficient and economical. This system consists of a bucket, running on an inclined or vertical track. A steel cable and winding machine hoists the bucket and the ashes are discharged into an overhead bunker. One man with a push or electric car collects the ashes from hoppers under the boilers and dumps them into the bucket. The entire operation then is automatic. The skip bucket dumps the ashes and returns for more. The entire trip takes two minutes.

Beaumont Skip Hoists cause less repair bills than any other system. Regardless of how many tons of hot, dripping wet ashes are carried daily, the abrasiveness of the ashes does not affect the running parts. Compare this with the amount of trouble and expense which this abrasiveness causes with other systems. High capacity; low operating, repair and installation costs; low power consumption, and freedom from breakdowns are distinct advantages found in the Beaumont Skip Hoist.

The Beaumont engineers will welcome an opportunity to discuss your ash handling problems for you. Write for the Beaumont book—"The Skip Hoist for Coal—Ashes—Coke."

Beaumont
ONE CONTRACT ONE RESPONSIBILITY

A Few Plants Using Beaumont Equipment

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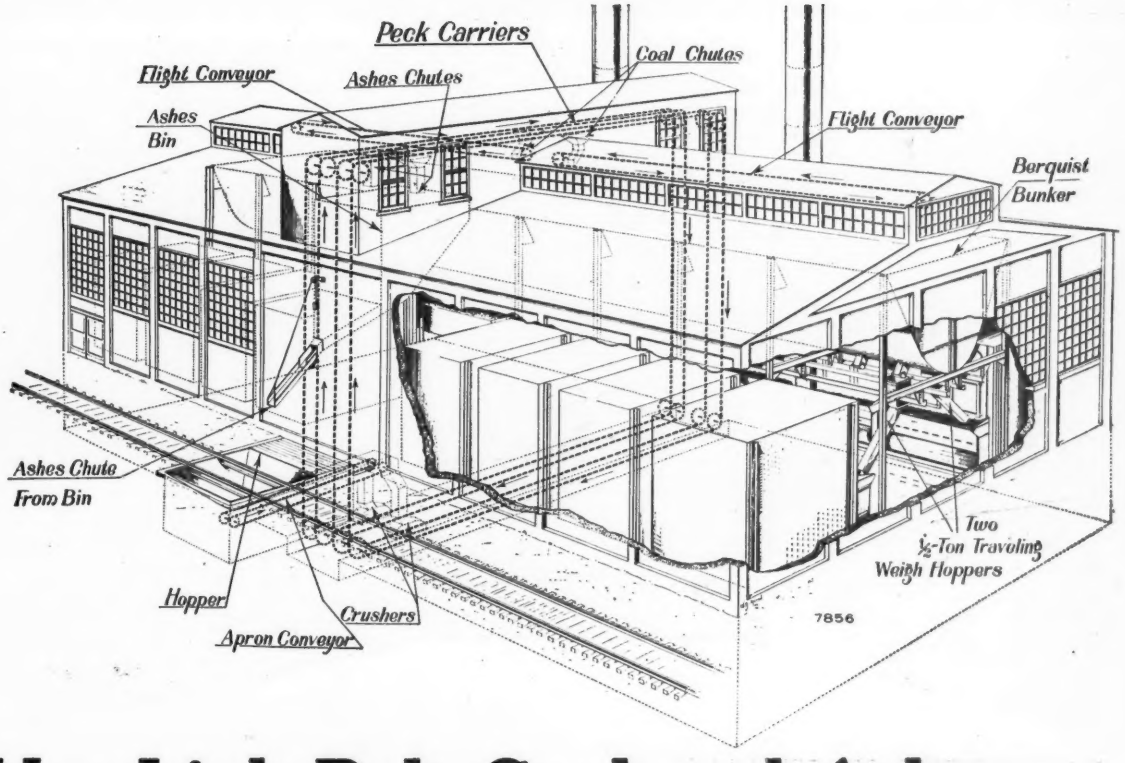
Beaumont Company specializes only on boiler houses and equipment used in their operation, and does not enter into any other kinds of engineering and construction work. It seems conservative, therefore, to claim that their organization is better qualified in size, knowledge and experience for this one class of work than any other in the country.

R·H· BEAUMONT CO·

Coal and Ash Handling Systems for Boiler Houses

344 Arch Street Philadelphia



Use Link-Belt Coal and Ashes Equipment in Your Boiler House

HOW much does it cost you to put coal into your furnaces and take away the ashes?

More money can be wasted here than in many other parts of your plant. The boiler room is an out-of-the-way place, and therefore not apt to receive the same careful watching accorded to other operations of the plant.

The simple and economical method of solving this difficult job is to let us fit one of our standard coal and ashes handling equipments in your boiler plant—and then you will appreciate, like hundreds of Link-Belt clients, how you can simplify this work, save labor and accomplish both at a lower cost per ton than you are now paying.

May we send one of our experienced engineers to take up your problem with you?
Write also for catalog No. 220

LINK-BELT COMPANY

313

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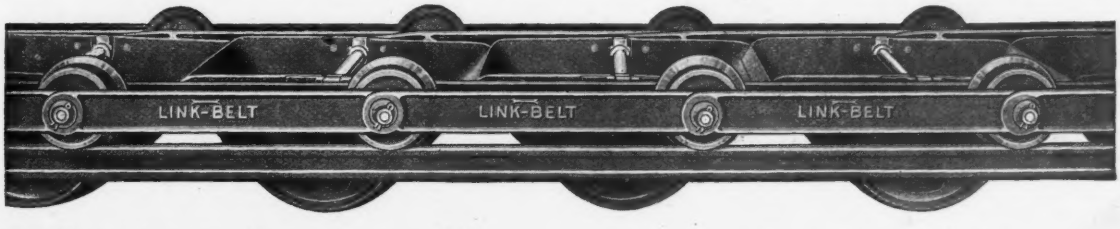
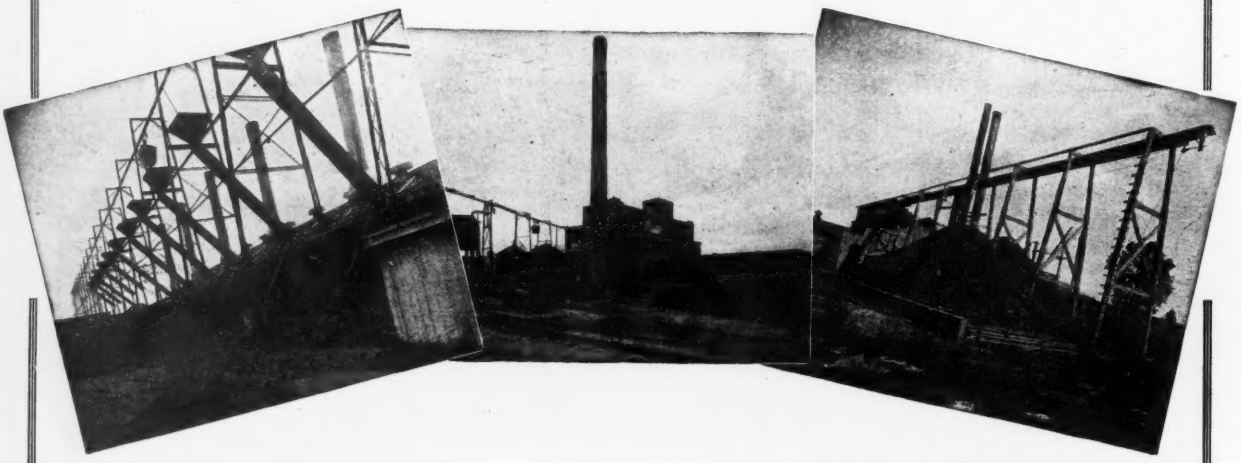
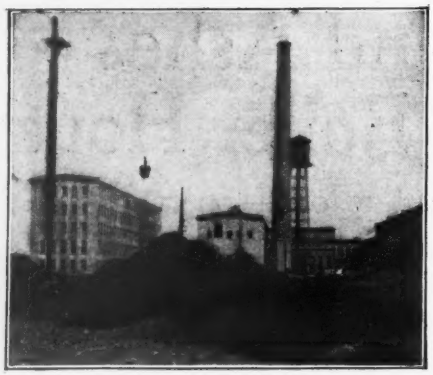
		Birmingham, Ala.	S. L. Morrow, 720 Brown-Marx Bldg.		

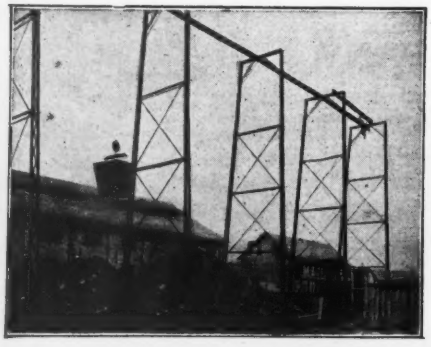


A Few Photographs of "Godfrey" Installations





Cableway Installation



I-Beam Installation

The pictures of these installations represent only 5 out of the 400 GODFREY CONVEYORS which are saving money for their owners throughout the country.

You can see Godfrey Conveyors in operation (let us tell you one that is near); you can talk to their owners; you can prove to yourself that these owners are being benefited from "Godfrey" service.

Beware of Imitations

While not pioneer conveyor manufacturers, we are the originators, patentees and manufacturers of the recognized highly-efficient type of conveyors operating gravity-filled bottom dump bucket over monorail.

While others are IMITATING this type of Conveyor, we are IMPROVING it.

Our present conveyor is an extraordinary saver of time and labor. Reports from owners in all parts of the country indicate that coal is being unloaded with the services of one man at an average power and labor cost of 5 to 7 cents per ton.

It is this consistent, efficient, money-saving service that is responsible for the growth of our business.

Our *own* specially equipped factory, our *experienced* organization and our *moral* and *financial responsibility* stand back of every conveyor.

Ask for our new catalogue.

Godfrey Conveyor Co.

114-134 13th St., Elkhart, Indiana

B-G STANDARDIZED CONVEYORS

Now as never before, all users of large quantities of coal realize the absolute necessity of storing coal and of handling —storing and reclaiming—by machinery.

The superiority of B-G machines for short-haul, loading and unloading problems is beyond question.

In Every Power Plant

B-G equipment has its place. B-G Conveyors for unloading cars and moving to storage piles. B-G loaders to reclaim from storage, loading wagons, wheelbarrows, cars or conveyors.

Hundreds of the biggest plants, both here and abroad, find them profitable—even a necessity. How about your plant?

B-G engineers are at your disposal to make suggestions and to work with you on the selection of equipment. This service is free. Tell us your problems.

Catalog M, just off the press, will be sent to those who can use it. It contains many installation photographs and stories of what B-G machines are doing. Have you your copy?

Barber-Greene Company

Aurora, Ill., U. S. A.

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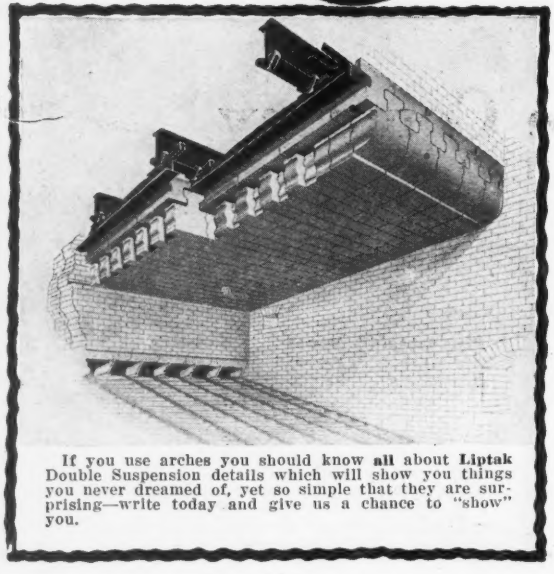
How do you buy an ARCH?

if you buy on an Efficiency Basis only *You'll take the* LIPTAK DOUBLE SUSPENSION ARCH



If you use arches you should know **all** about **Liptak** Double Suspension details which will show you things you never dreamed of, yet so simple that they are surprising—write today and give us a chance to "show" you.

Because Liptak Double Suspension construction positively prevents any forced shut-downs due to falling arches. The main arch next to the fire can be entirely used up and yet the emergency arch enables you to continue firing until it is convenient to make repairs. Then anyone can make them.

Two dead air spaces between the arches and frame render the arch air tight, therefore heat tight. No heat can escape to the boiler room. Thousands of additional horse-power are so developed with resulting economy in fuel consumption.

Liptak Double-Tied Warp-Proof Side Walls

like Liptak Arches, greatly reduce the upkeep cost of boiler or furnace walls. With this construction you can repair that part which is burned out without disturbing any of the rest of the wall—all cracking, warping and sagging is absolutely prevented.

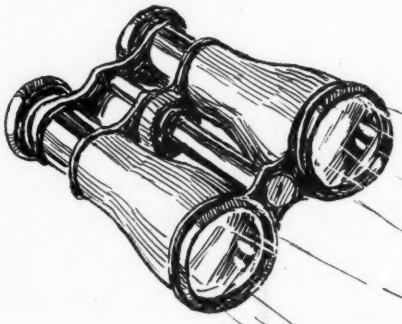
Our engineers will gladly submit to you figures and design of either Arch or Side Wall which will economically solve your problems. Send us a blue print or sketch of your furnace arrangement. It may mean a big saving.

Liptak Fire-Brick Arch Company

Manufacturers of **Liptak Double Suspension Arches and Liptak Double-Tied Warp-Proof Side Walls**

609 2nd Avenue, South **MINNEAPOLIS**

VISION



Vision in producing boiler settings to survive the extreme temperatures of present day underfeed stoker-fired furnaces—*such* had the McLeod & Henry Company when they looked forward to making a furnace lining that in both composition and construction would surpass the ordinary size fire brick. Their inspired vision resulted in

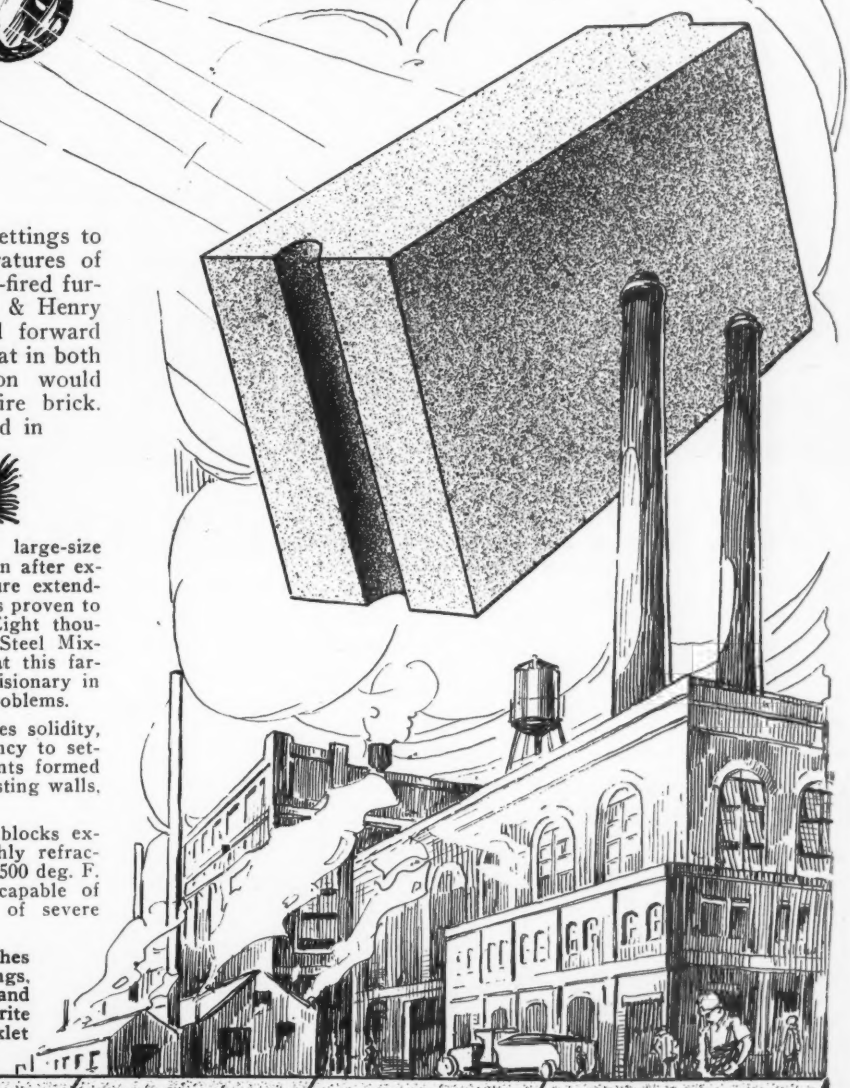
"STEEL MIXTURE"

The mental picture of this large-size tongued and grooved block—born after experience in fire brick manufacture extending over a period of 75 years—has proven to have been a prophetic sight. Eight thousand power plants now using "Steel Mixture" is the visible evidence that this far-sighted image was not purely visionary in its adaption to boiler furnace problems.

Their type of construction insures solidity, tightness, strength and permanency to settings. The fewer number of joints formed results in labor saving, longer lasting walls, less clinker trouble.

Their composition makes these blocks extremely tough, durable and highly refractory. They will not fuse below 3500 deg. F. and have a crushing strength capable of withstanding the great strains of severe service.

Made for Boiler Door Arches and Jambs, Fire Box Linings, Back and Inner Arches and Blow-Off Pipe Protectors. Write for our "Measurement Booklet No. 38."



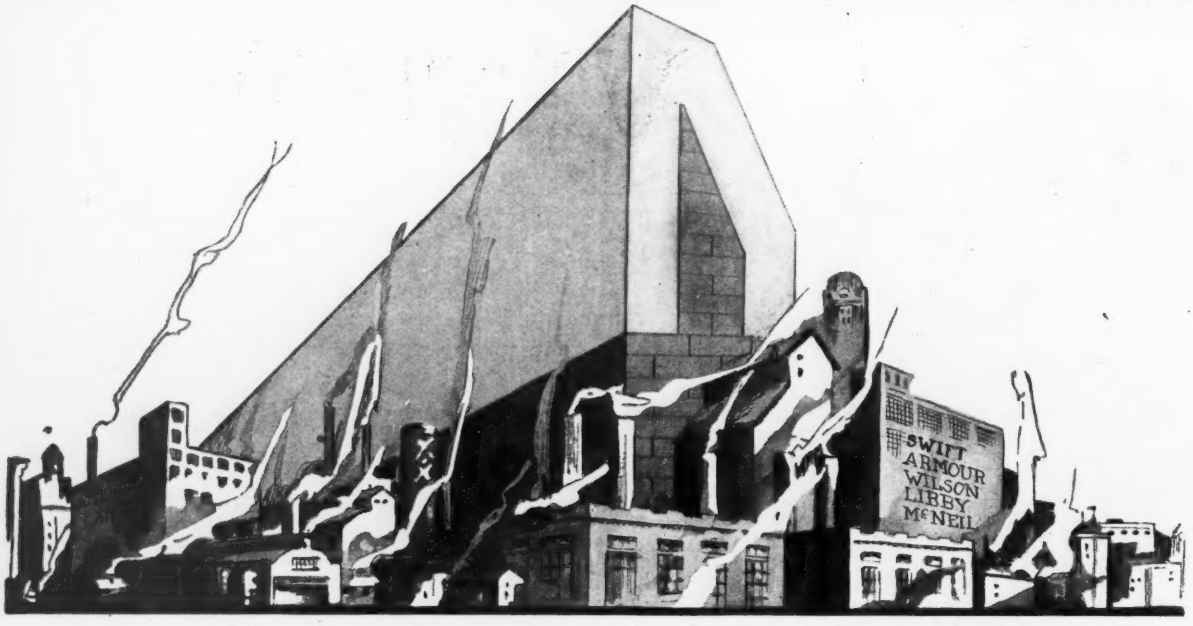
"STEEL MIXTURE"

McLeod & Henry Co.

1825

BOSTON NEW YORK DETROIT

TROY N.Y.U.S.A.



Backing Up Successful Plants

all over the country in their fight to keep down fuel costs by making air-tight, gas-tight furnace linings that assure permanent fuel economy and eliminate shut-downs is the great service given by

PLIBRICO
JOINTLESS
FURNACE LINING

Plibrico

is easily applied and when set makes any furnace absolutely air-tight. The absence of joints makes the lining last longer; in fact, it often outlives two or three ordinary brick settings. Think what that saves in trouble and expense for frequent repairs.

Successful business building is not the toleration of wastes. Instead, it is the result of employing only that equipment which gives the maximum in service, with minimum maintenance expense.

By stopping all leaks heat waste up the chimney is prevented and combustion is improved.

Plibrico, Devil's Putty, is applied with a mallet and smoothed with a trowel, and is applicable to any or every type of boiler, for new settings or for patching old settings. Withstands temperature up to 3100 degrees F.

No mortar can fall out—no joints in which clinkers can lodge.

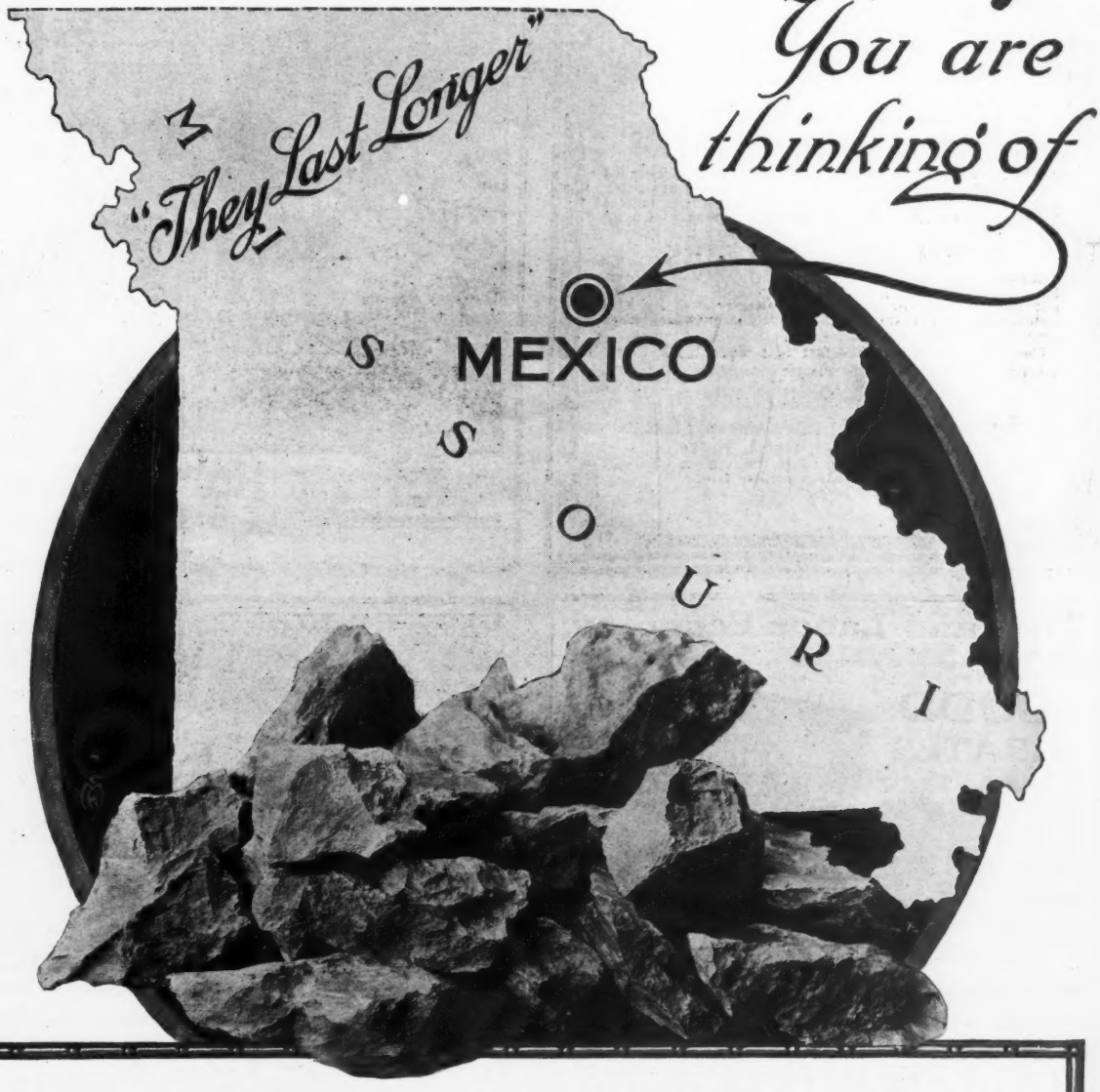
Plibrico is delivered only in steel packages of distinctive appearance as shown below.

Warehouse Stocks carried in all principal cities for immediate deliveries.

A trial will convince you. Guaranteed satisfactory. Write today for illustrated book on Furnace Linings.

JOINTLESS
FIRE BRICK CO.
1130-1150 CLAY ST. CHICAGO.

When you think of High Grade Missouri Fire Clays *You are thinking of*

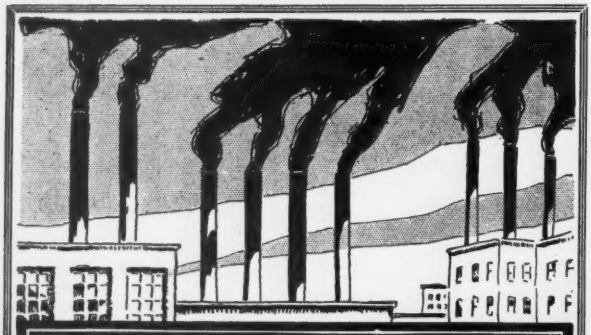


This Is A Photograph Of Fire Clay Selected By Hand In An Open-Air, Daylight Pit—A. P. Green Fire Brick Must Be Good

Put our name on your list. Send us your inquiries. Ask for samples—then examine and test those samples. That's the way to demonstrate the extra service you can get from A. P. Green fire brick and fire clay shapes.

A. P. GREEN FIRE BRICK CO.

MEXICO, MISSOURI



INSTALL PERMANENT ONE-PIECE FURNACE LININGS

Avoid the costly and all too frequent shut downs caused by the failure of linings laid up with separate fire brick and mortar joints. The one-piece lining is the logical lining because there are no separate bricks and clay joints.

BETSON PLASTIC FIRE BRICK

makes it easy for anyone to form in place solid, seamless, monolithic boiler furnace linings and baffles, without special tools or forms. The work is easily and quickly done. It costs less to install and outwears other linings many times over.

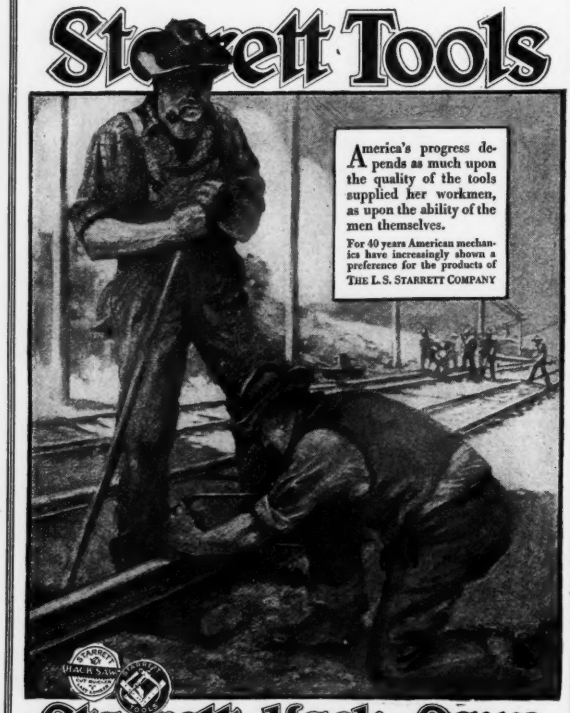
"The first cost is less, the last cost much less."

Remember there is but one "Plastic Fire Brick"—Betson's.

Send for valuable booklet of boiler room information. It's free for the asking

Betson Plastic Fire Brick Company, Inc.
P. O. Box 386-1, Rome, N. Y.
New York Office: 50-1 Church St.
Shipments made promptly from warehouses in principal cities.

Starrett Tools


America's progress depends as much upon the quality of the tools supplied her workmen, as upon the ability of the men themselves.
For 40 years American mechanics have increasingly shown a preference for the products of
THE L. S. STARRETT COMPANY

Starrett Hack Saws

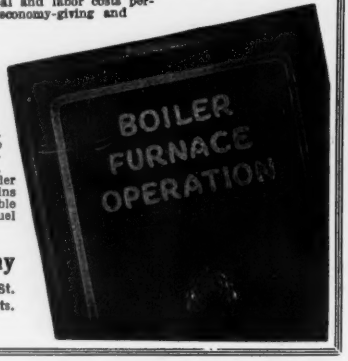
42 63

Coal and Labor Economy

Surely, with present high coal and labor costs persisting, you feel the need of economy-giving and trouble-free devices, and

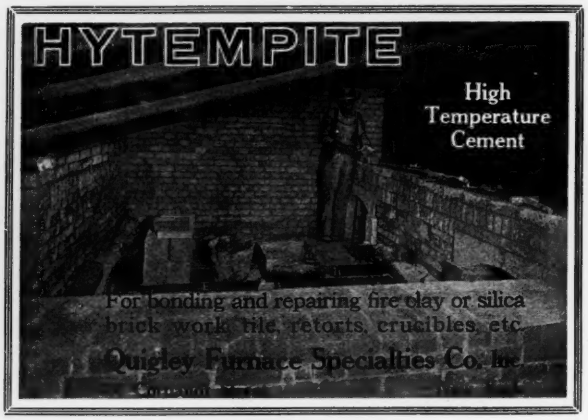
BUDD GRATES

are built for that very purpose. The advantages, such as the elimination of clinkers, the staggered teeth, and many others, are described fully in "Boiler Furnace Operation." It explains why Budd Grates are so durable and effective for combating fuel waste. Send for it today.



Budd Grate Company
Offices: 2011-13 E. Letterly St.
Works: Adams to Letterly Sts.
PHILADELPHIA, PA.

HYTEMPITE


High
Temperature
Cement
For bonding and repairing fire clay or silica brick work, tile, retorts, crucibles, etc.
Quigley Furnace Specialties Co. Inc.

WIEDERHOLDT CHIMNEYS

Will Outlast Your Requirements Without Repairs

Send for free booklet "Modern Chimney" and let us figure on your work

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No. 416 Olive Street
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Flat Suspended Arches

Also Mfrs. of Detrick-Hagan Steam Jet Ash Conveyors

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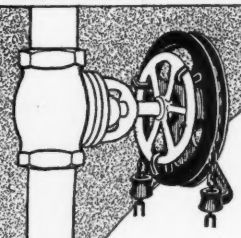


EASY TO ATTACH

And ADJUSTABLE to any type, make or size of valve; these are the features that account for the low cost, quick delivery and popularity of the

Babbitt
—Adjustable—
SPROCKET RIM
with Chain Guide

for operating overhead valves.

The universal application and standardization has reduced the cost per unit to a minimum, for just ten sizes do away with the thousands of special chain wheels necessary for the many types of valves.

Therefore, you can afford to put one on every overhead valve in your plant, but you can't afford to be without them. They save you accidents, claims, time and annoyance.

We have distributors in every large city.

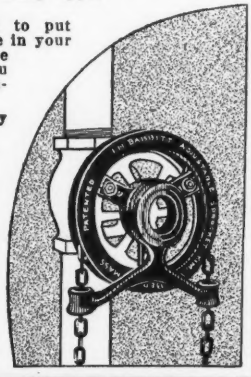
Write Today for Literature to the

BABBITT STEAM SPECIALTY COMPANY

New Bedford, Mass.

Western Distributors: Jenkins Bros., 646 Washington Blvd., Chicago, Ill.

Manufactured and Sold in Canada by the Engineering Specialties Co., Ltd., Toronto, Ontario, Can.



More Steam Less Money

is the record in the plants that are burning the 25,000 tons per day of lignite, low-grade bituminous and other coals that are made into highly efficient fuels by

Fuller Mill, Gear Driven

FULLER-LEHIGH
Pulverized Coal Equipment

It not only utilizes many fuels otherwise wasted, but eliminates smoke, cuts down the labor and increases plant capacity.

The cost per ton of preparation is so low a very large profit is possible in comparison with the cost of competing fuels.

Let us send you catalogue and other valuable data.

Fuller-Lehigh Co.

Main Office and Works Are Located at
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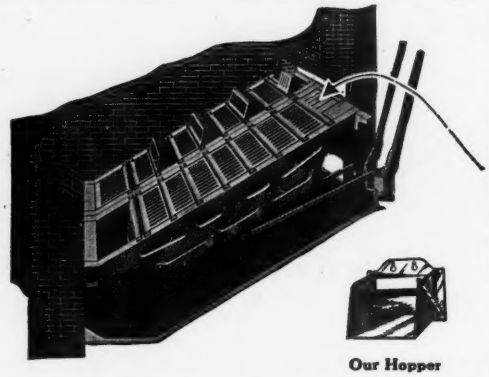
BRANCH OFFICES: 50 Church St., New York City; 1336 McCormick Bldg., Chicago; 1915 L. C. Smith Bldg., Seattle, Wash.; 25 Victoria St., Westminster, S. W. I., London; Brussels, Belgium, 101 Boulevard Adolphe Max; Hamburg I, "Wallhof," Glockengiesserwall 2, Germany. PE



Our Hopper

"By Their Use We Are Saving 20% In Fuel"

The above is from letters from users of the Vasil Hand Stoker. Would that or an approximate saving interest you?

We do not claim to make that much in all cases, but we will guarantee a material saving if you install and properly use the Vasil Hand Stoker.

It eliminates smoke by consuming it, increases boiler capacity, increases boiler efficiency, saves fuel, decreases labor of the fireman and reduces repair bills to a minimum.

Let our engineers "show you" and convince you that we have the simplest, strongest and most reliable stoker on the market. Then install it and save its price within a short time in fuel saving alone.

VASIL STEAM SYSTEMS COMPANY

314-318 Washington Loan & Trust Building

Agents Wanted Washington, D. C.

"UNION" FUSES

are made in both renewable and non-renewable types. Guaranteed to give satisfaction. Money back if they fail. Booklet on request.

CHICAGO FUSE MFG. CO.
Chicago New York

Mechanically Correct

That's why not one change in design or construction was necessary for

TRICO FUSES

to receive the complete approval of all sizes and types the Underwriters Laboratories placed upon them.

Minimize fire and explosion danger, and reduce fuse maintenance expense about 80%.

Noiseless in operation.

Durable and effective in service.

Only one element can be installed in a casing, therefore, no overloading.

For more information address

THE M. B. AUSTIN COMPANY

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Chicago Illinois

"The Grate With Enthusiastic Users"

Never Dumps a Lump

The Martin Grate

Great for producing efficient steaming results on low priced fuels. Maximum heat is generated with a minimum amount of coal.

Distribution of draft is kept even. No dead spots in fire.

The rocking movement of the bars slices the bottom of the fire only, and nothing but ashes fall into the pit.

Over twenty years of satisfactory service proves their lasting and durable performance.

For use on water-tube and return tubular boilers of any style.

Write for catalog.

Martin Grate Company

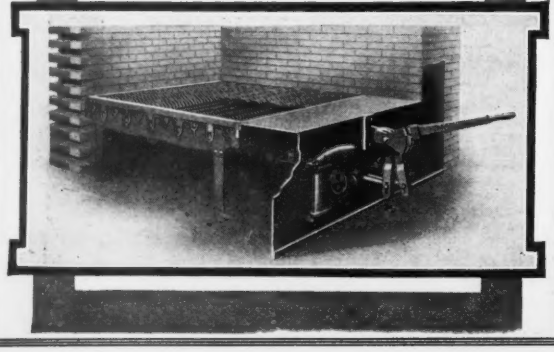
345 South Dearborn Street **Chicago, Illinois**

AJAX GRATES

Fifteen per cent less coal and greater steam production—that's what AJAX Grates will do for you—and are doing for others.

Get our complete booklet: "The Economical Burning of Coal," a treatise that will interest every power plant owner or operator.

Valley Iron Works
Williamsport, Penna.



ORIGINAL HAND STOKER

HUBER HAND STOKER

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Sole Manufacturers

FLYNN & EMRICH CO.

Established over 70 years

Baltimore, Maryland

FILES STOKERS

Hand Operated

Adapted to any furnace using coal as fuel, Files Stokers can be installed under your boilers in 48 hours—a week-end job. No changed settings, no defaced fronts. no objectionable projections. Just a series of hand levers that enable you to clean the fire, remove ash and clinker, and distribute the coal without opening the fire door.

Bulletin J explains how Files Stokers will materially decrease your fuel costs. Write for it!

THE FILES ENGINEERING CO., Inc.

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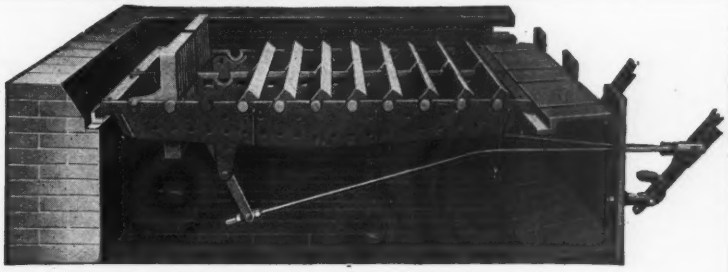
KELLY GRATES GOSHEN IND.

When You Buy
Kelly Grates
You Buy Results

KELLY GRATES GOSHEN IND.



Wizards of Economy

Kelly Rocking and Dumping Grates cost little to install. They require no changes in the furnace and are made in sizes to fit any furnace, large or small.

There are no extra parts to run up repair bills, no laborious slicing or slashing, as cleaning is effected through closed doors.

Kelly Grates effect almost perfect combustion with any grade of coal used, assuring a saving of from 5 to 25%.

There's a grate fitted to establish such saving in your plant. Write for Catalogue "C." It will give you the complete story.

The Kelly Foundry & Machine Co.

GOSHEN, INDIANA

Established 1887 **Power Plant Engineers** **617 Ninth St.**
New York Office: 59 Park Place **Chicago Office: 5 N. La Salle St.**

THE SAVING PRINCIPLE

of the

CANTON Rocking and Dumping Grate

does more than save coal; it also enables you to burn the **poorest kind of coal.** The Canton Grate makes for perfect combustion, clean, even fires, and prolongs the life of the boiler. Absolutely guaranteed.
Write for literature. Our price will interest you.

Canton Grate Company

1708 Woodland Avenue, Canton, Ohio

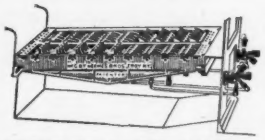
Southern Offices.
829 Trust Co. of Ga. Bldg.
Atlanta, Ga.

"Fits My Idea of Great Efficiency"

That's what you'll say after you know the facts about a

NEEMES GRATE

Highly efficient because it makes for more perfect combustion of every pound of coal fed to it, thus permitting better results from cheaper coal and also a reduction in the amount of fuel used.



Shakes out the ashes; cuts out the clinkers; dumps the fire. **Write today for full particulars.**

NEEMES BROS., INC.

186-196 1st Street TROY, N. Y.

MANUFACTURERS OF ROUND AND SQUARE GRATES
Babcock & Wilcox, Ltd., Montreal, Canada, Sole Makers for Canada. Burke Engineering Co., 525 Industrial Building, Providence, R. I., Sole Agents for the New England States.

Burn the Cheapest Coal

"Stands on Its Own Feet"

as many of the large central stations as well as small plants have been doing the last few years, at a big profit, with

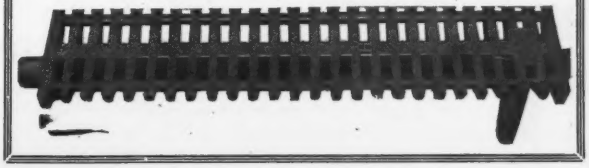
HERRICK Shaking Grates

They are built of the best gray iron to give the highest combustion efficiency and longest life. A record of fourteen years continuous service in one plant and eight years in another, is evidence of their lasting qualities.
Free combustion is assured by the ample air space between grate bars. Cleaning can be done with the fire doors closed, allowing no cold air to enter.
They stand on their own feet. Write for bulletin "A Grate Proposition." It is free.
Good agents wanted in open territory. Best co-operation and inducements.

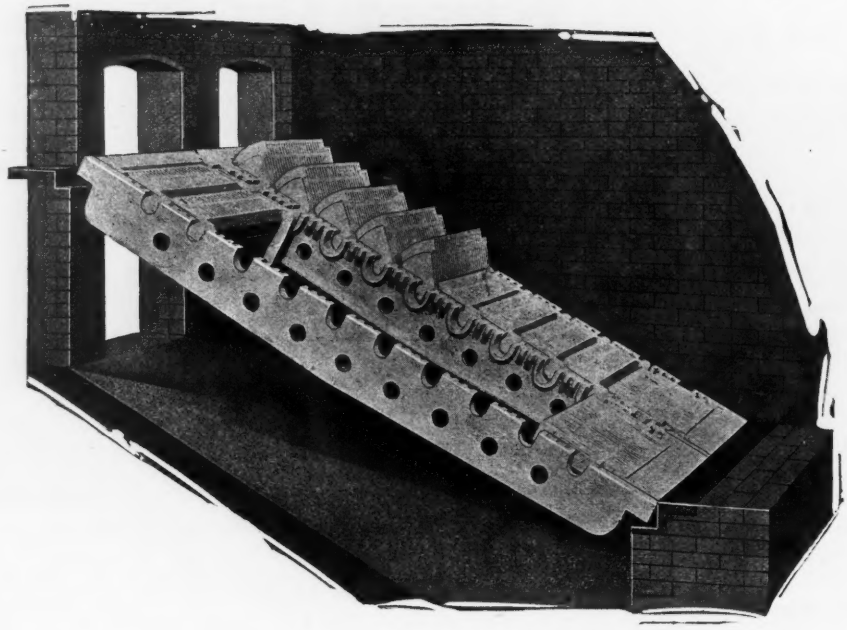
Sales Representatives Can Make Money
following up our inquiries. Write

Geo. S. Herrick Grate Co.

Syracuse, New York



A Way to Meet the Coal Situation



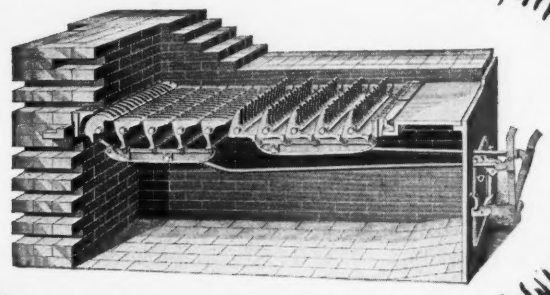
Marion Hand Stokers

will give practically the efficiency and high driving capacity of the mechanical stoker, with an insignificant maintenance cost and no operating charge. A few operations of the levers on the outside of the setting by the fireman is all the power required for its operation, and requires very little effort. They will burn the lowest grades of fuel, insure the highest driving capacity and smokeless combustion.

SEND FOR FOLDER ON HAND STOKERS

MARION MACHINE, FOUNDRY & SUPPLY CO.

Box 400, MARION, IND.



Remember! McClave Grates Burn the Cheapest Coal Efficiently

Fortune Smiles

on the power plant that combats today's steep coal prices with **McCLAVE GRATES.** They burn the cheap refuse grades with thorough efficiency.

It takes a combustion machine like the **McCLAVE** to do this—to get all the heat units out of any coal it burns.

No raking or slicing with **McCLAVE GRATES.** Fires cleaned of ashes and clinkers by the outside levers with fire doors closed. No inrushing of cold air. Grates may be cleaned in sections by using the Cut-Off movement.

Grate tops built in small removable sections quickly replaced when necessary. Maintenance costs negligible.

Our **ARGAND BLOWERS** assure a steady draft of steam-laden air that softens clinkers and makes their removal easy.

Catalog D describes fully. Write for copy.

McClave-Brooks Company

Main Office and Works

Scranton, Pennsylvania

New York Office: Rm. 351, 50 Church St. S. C. Smith, Manager.

Philadelphia Office: 400 Morris Building, George Blair, Jr., Coal & Equipment Co., Rep.

Chicago Office: 515 Hearst Bldg. F. G. Smith, Manager.

New Orleans: 5027 S. Robertson St., D. W. Robertson, Rep.

Boston: A. R. St. John, Mgr., 261 Franklin St.

Syracuse: W. H. Goodrich, Mgr., 130 Hope Ave.

Texas Rep.: D. G. Counts, 705 Elm St., Dallas, Tex.

ENGINEERING CO

To the
Stoker Buyer

Selling Agents for Coppus Blowers in New York State, New England, and Philadelphia Territory.

the standard of excellence maintained by the G. M. C. Engineering Company throughout its organization is assurance of the merit of its products.

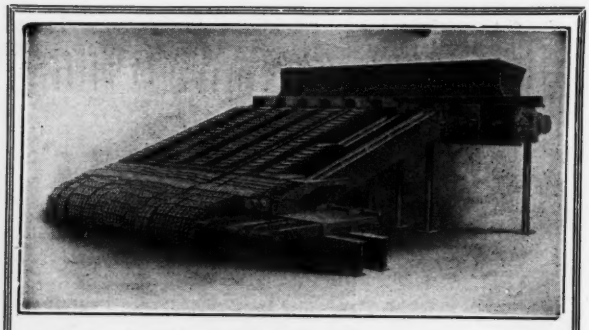
Knowledge, time-tried and tested, is the material upon which every detail of manufacture is based.

Evidence of high quality is shown by the record of the G. M. C. Stokers shown above. For a period of four years, eight of these stokers have seen continuous service. During that time they have not once needed repairs nor required more than a 3-hp. motor to operate them.

The standards that have built such efficiency are at your command. Our Engineering Department will gladly co-operate with you in solving your problems.

Write for our new catalogue.

G. M. C. Engineering Co., Graphic Arts Bldg. Worcester, Mass.



Riley Stoker Grate Construction

Each and every line of grates, extending from the front to the rear, can be operated independently of all others.

RILEY UNDERFEED STOKERS

It is therefore possible by changing the length of movement of one or more of these grate sections to alter the condition of the fuel bed in any one spot, in front or in back, without affecting the general condition of the fire.

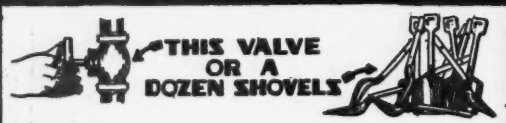
A Riley fuel bed—means better operating conditions—higher efficiency—greater capacity—less fuel and labor—and reduced maintenance.

Catalog PE-12 explains the live grate construction

STOKER MANUFACTURERS ASSOCIATION SMA

Sanford Riley Stoker Co.
WORCESTER, MASS.
Boston New York Philadelphia
Pittsburgh Buffalo Cleveland
Detroit Cincinnati Chicago
Denver St. Paul

TRADE MARK Rx REGISTERED



Which?

Hammelising your boiler plant accomplishes much more than the generation of power at a lower fuel cost.

Eighty per cent of the direct labor in a boiler plant may be saved through the Hammel System, the capacity of boiler and stack greatly increased, instant flexibility always available.

HAMMEL OIL BURNING EQUIPMENT COMPANY
185 Devonshire St., Boston, Mass. 110-10

HAMMEL OIL BURNING SYSTEMS

WRITE FOR "TWELVE FUEL FACTS"

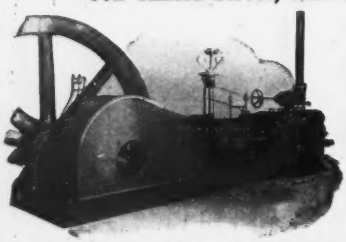
Wire, write or phone for this interesting, profusely illustrated story of the Harrington Universal Stoker, the only stoker that burns successfully all such grades of coal as Coke Breeze, Lignite, Bituminous Coal, and Washer Refuse.

THE JAMES A. BRADY FOUNDRY COMPANY
Jos. Harrington, Vice-President and Engineer
46th Street and Western Boulevard
Chicago, Illinois

Established 1867

The Vilter Mfg. Company

972 Clinton Street, Milwaukee, Wis.



Builders of High Grade
CORLISS ENGINES
for Belted or Direct Connected Service
Ice Machines

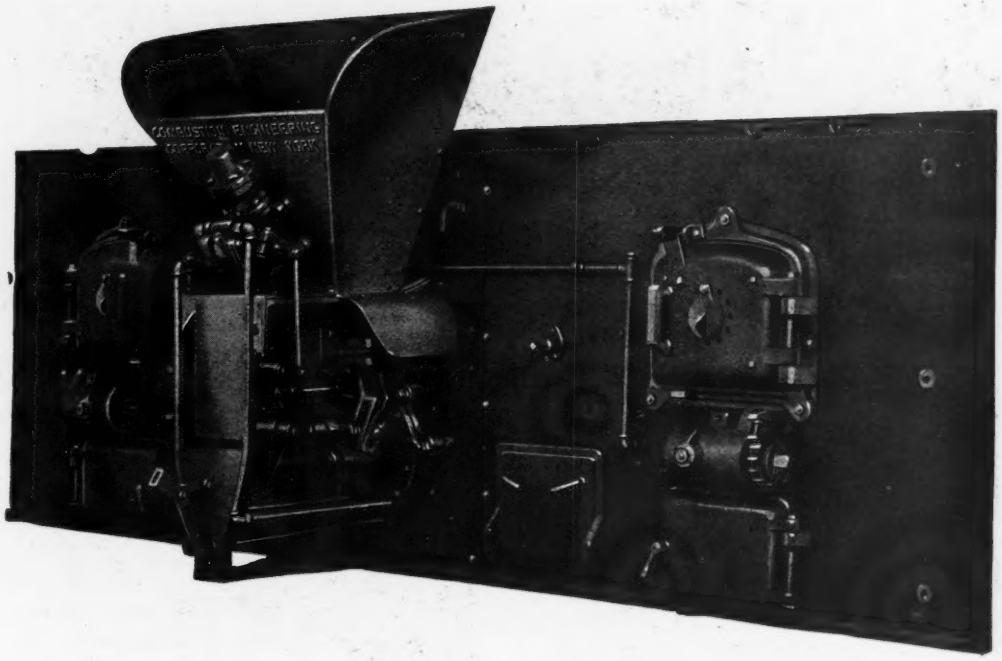
Chicago Office, 731 Monadnock Block

Frederick
Underfeed
Stokers
Steam Jet
Ash Conveyors

Write for full particulars and consult our Engineering Staff freely.

THE FREDERICK ENGINEERING CO.
FREDERICK, MARYLAND
Main Sales Office: 61 Broadway, New York
District Offices in All Principal Cities

Adaptability



TYPE E STOKERS

have been adapted with little change to existing boilers in a large number of plants—enabling their owners to meet conditions created by the unfavorable coal market.

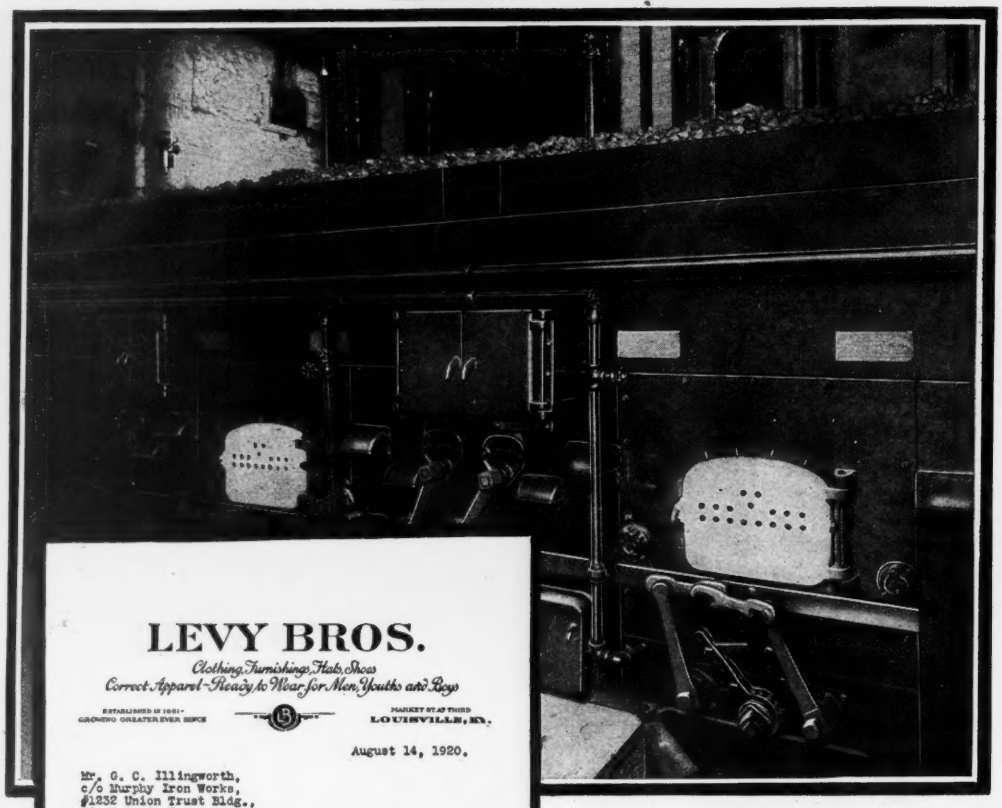
Get the facts from us

Combustion Engineering Corporation
11 Broadway, New York City

Owners and manufacturers of
Lopulco Pulverized Fuel Systems

Type E Stokers—For Bituminous Coal. The Grieve Grate—Hand-Firing
Coxe Stokers—Anthracite Coal—Coke Breeze and All Low Grade Coals
PHILADELPHIA, PA. PITTSBURGH, PA. MINNEAPOLIS, MINN.
BIRMINGHAM, ALA. HAZLETON, PA. BOSTON, MASS.
CHICAGO, ILL. SALT LAKE CITY, UTAH MILWAUKEE, WIS.
OMAHA, NEB. ALBANY, N. Y. DENVER, COLO. DETROIT, MICH.
TAYLOR ENGINEERING CO., VANCOUVER, B. C.
ATLANTA, GA.

$35.00 Maintains 2 Stokers For 10 Years



LEVY BROS.

Clothing, Furnishings, Hats, Shoes
Correct Apparel—Ready to Wear for Men, Youths and Boys

ESTABLISHED IN 1861—GROWING GREATER EVER SINCE

MARKET ST. AT THIRD
LOUISVILLE, KY.

August 14, 1920.

Mr. C. C. Illingworth,
c/o Murphy Iron Works,
1232 Union Trust Bldg.,
Cincinnati, O.

Dear Sir:

Your letter of August 12th to hand, and I am very glad to have the opportunity to express my opinion regarding the two Murphy Stokers, under 150 H. P. boilers, I have had in my charge since 1910.

During the first four years I was making steam for two engines at a rate of 13 hours per day, during the last six years for heating the building in cold weather. I have the satisfaction to say that during the entire time of ten years I lost one grate bar. I have to this date the first arches, clinker rolls and other parts of stokers in good condition.

As to the maintaining expense of your two stokers, I will say that $35. would cover everything, including fire brick and fire clay for door linings.

It always gives me pleasure to speak well for any good machine I have had during my forty years experience, and for your stokers I cannot say enough.

Hoping this record will be of some interest to you, I beg to remain,

Yours truly,

P. T. Reinberg E.
Levy Bros.

Performance over a period of 10 years such as is indicated in the letter reproduced herewith speaks well not only for the design and construction of the

MURPHY AUTOMATIC FURNACES

but equally as well for good operation on the part of the Chief Engineer.

If you hesitate about installing stokers because you fear large repair bills, it will pay you to read carefully this letter.

To fully acquaint yourself with the design and construction of the Murphy Furnace which makes such records possible send for Catalog PE-12

MURPHY IRON WORKS, Detroit, Michigan

BOSTON WORCESTER NEW YORK PHILADELPHIA PITTSBURGH BUFFALO
CLEVELAND CINCINNATI CHICAGO ST. PAUL DENVER

BURNS ANY FUEL THAT HAS HEAT IN IT

Jones "A-C" Stokers in boiler room of Flour State Baking Co., Minneapolis, Minn.

Continuous Operation

The Unbroken Efficiency Curve

Uninterrupted Service Means Lowest Cost Per Ton of Coal Fired

THE Jones "A-C" Stoker has been adopted by foremost plants, not alone because it meets heavy overloads and burns a wide range of coals at highest efficiency, but because it *continues* to do this throughout the year. In calculating the return on your stoker investment test results must give way to *extended operating records.*

Here are some plant records that mean even more, from a dollar and cents standpoint, than the unequaled test results for which Jones "A-C" Stokers are famous.

Five Months of Steady Overloads—Boilers at the American Diamalt Co., Cincinnati, Ohio, were kept on the line continuously for five months, operating at 150% to 250% of rating. Wiley Craig, Ch. Engr.

Three Months of Continuous Operation at High Capacity—Boilers at the Ford Hospital, Detroit, Michigan, were kept on the line continuously for over three months, loads varying from 75% of rating to 250%. Chas. Koehler, Ch. Engr.

Three Months of Continuous Operation With Peak Loads of 340 Per Cent—Boilers at the Michigan Limestone and Chemical Company on the line continuously for three months, loads varying from rating to 340%. C. R. Fisher, Ch. Engr.

The extreme simplicity of the Jones "A-C", reducing maintenance, and practically eliminating shut-downs; the automatic cleaning ("A-C") feature overcoming clinker trouble, and the all-but-perfect application of the under-feed principle of combustion enables the Jones "A-C" to duplicate in daily operation all it accomplishes on the test run. Write for the new "A-C" Catalog explaining ten basic points of Jones superiority.

The Under-Feed Stoker Co. of America

General Offices: Book Building, Detroit

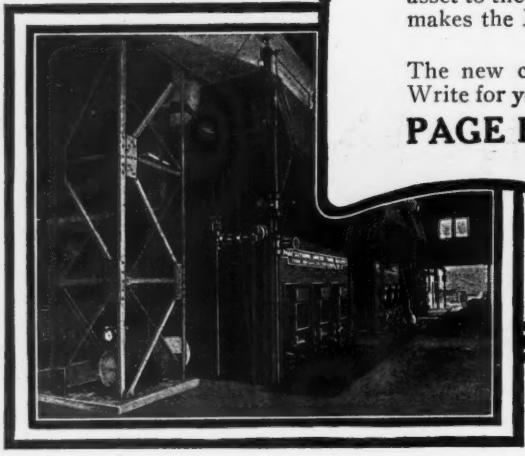
Boston, Buffalo, Charlotte, Chicago, Cincinnati, Cleveland, Denver, Kansas City, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, Salt Lake City, Seattle

The Under-Feed Stoker Co. of Canada, Ltd., 81 Victoria St., Toronto

Sole Manufacturers in the U. S. and Canada of the Jones Under-Feed Stoker

Jones "A-C"

Page Water Tube Boilers



Limited Space
Need Not Mean Limited Boiler Capacity

PAGE double boiler construction—the Page method of alternately crossing boiler tubes—means practically twice the boiler capacity in the same space occupied by the ordinary type of water tube boiler.

The advantage of installing a boiler that is standardized in every detail is understood and recognized by every power user who has experienced the expense and trouble surrounding the special construction work and specially designed foundations and setting involved in erecting the common type of water tube boiler. Compactness—that foremost Page advantage—is just as great an asset to the new plant, as to the existing plant where limited space makes the Page a necessity.

NEW LARGE CATALOG FREE

The new catalog unfolds the many superiorities of the Page. Write for your copy.

PAGE BOILER CO., 816 Larrabee St., Chicago, Ill.

Babcock & Wilcox—Stirling—Rust

Water Tube Steam Boilers

Steam Superheaters **Mechanical Stokers**

The Babcock & Wilcox Company

85 Liberty Street, New York **Works: Barberton, Ohio; Bayonne, New Jersey**

Atlanta.....Candler Building
Boston.....40 Federal St.
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Salt Lake City....705-6 Kearns Building
San Francisco.....Sheldon Building
Seattle.....1914-17 L. C. Smith Bldg.

"GEARY"
Water Tube Boiler

for high-pressure power purposes

Steel Construction Throughout
Straight Tubes

Write for descriptive literature!

OIL CITY BOILER WORKS
OIL CITY, PA.

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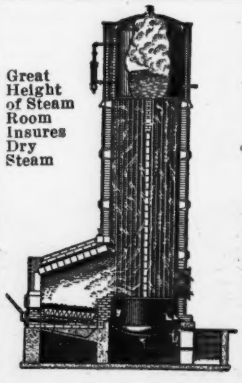


Wickes Vertical Water Tube Boiler

Ask us why engines are never wrecked and steam turbines never have eroded and clogged blades and nozzles when using this boiler.

Ask for Bulletins, "Saving Coal in Steam Power Plants" and "Aids in the Selection of a Steam Boiler." Sent free.

The Wickes Boiler Company
Saginaw Michigan

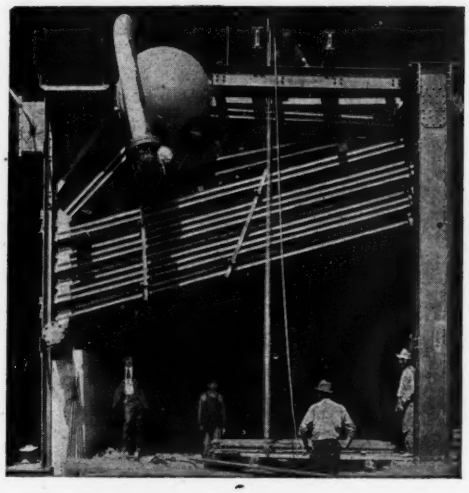
Sales Offices:
New York City, 1716 West St. Bldg.; Chicago, 76 West Monroe St.; Pittsburgh, 1218 Empire Bldg.; Boston, 201 Devonshire St.; Detroit, 1116 Penobscot Bldg.; Seattle, 736 Henry Bldg.

Why Large Power Users Endorse Springfield Water Tube Boilers

Sectional—Sinuous Headers
All Steel Construction
No Stay Bolts. *No* Bent Tubes
No Rods or Braces
Sections Individually Suspended

SPRINGFIELD BOILERS

Rapid and Thorough Circulation.
Indestructible Baffles
Staggered Tubes.
One hand-hole for each *four* tubes
Large Steaming Capacity.
No Riveted Seams Connecting Headers to Drum



Easy to Install

Expanding a few tubes is the only mechanical work necessary in the process of erection. Any part of the boiler will pass through an opening 6 ft. square. SPRINGFIELD boilers require less space and less brickwork than most other boilers.

Write for catalog.

Springfield Boiler Co., Springfield, Ill.

OFFICES:

Chicago—New York—Philadelphia—Pittsburgh—Kansas City—Denver—Shanghai, China

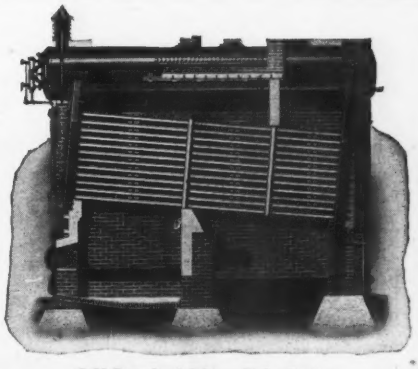
The C-H Water Tube Boiler

All Steel Construction

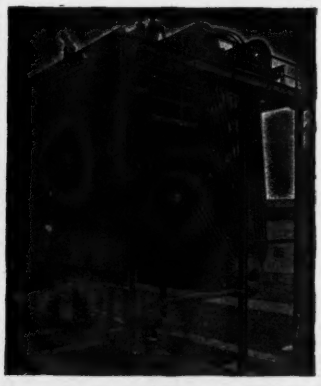
Vertical or Horizontal Baffle, inside type forged steel handhole plates. Units of any size for any purpose. We also build Horizontal Tubular and Marine Type Boilers.

The Casey-Hedges Co.

New York **Chattanooga** **Chicago**



C-H Standard Water Tube Boiler



Connelly (Patented) Water Tube Boilers

are of the 4 drum type, have 100% tube area in the path of the circulation, and deliver steam superheated 5 to 10°

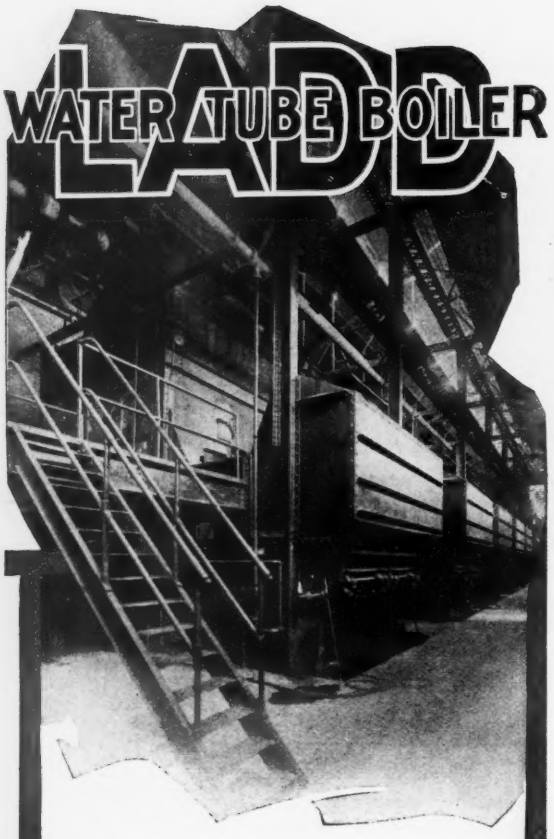
Simple in design, have no flat surfaces, no stay bolts, no crown bars or braces and free from hundreds of joints—no handholes.
Easily accessible for cleaning internally and externally.
Can be built in units up to about 4000 H. P. and 300 lbs. pressure.

Write for Our New Catalog, Desk 7

The D. Connelly Boiler Company, Cleveland, Ohio

Founded in 1875 by Daniel Connelly

LADD WATER TUBE BOILER

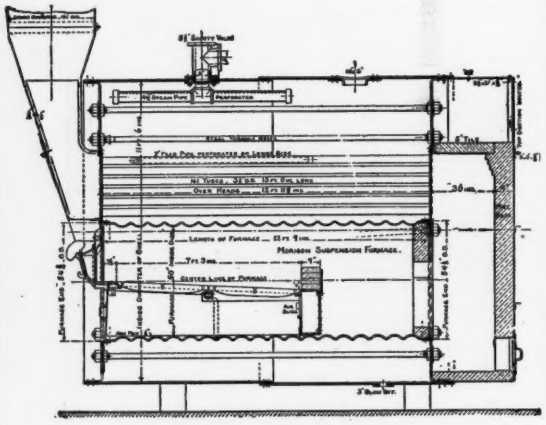


Can be built from the smallest practical water tube unit up to 1500 H. P. in the single type and to upward of 5000 H. P. in the Multi Drum Type.

Write for descriptive catalogue and list of prominent users

The GEORGE T. LADD COMPANY
First National Bank Building
Pittsburgh, Pa.
Chicago office:- 528 McCormick Bldg. Chicago, Ill.

Freeman Manufacturing Co.
Racine, Wisconsin
Manufacturers of
Internally Fired Boilers
Water Tube and Horizontal Tubular



Smoke Stacks
Tanks, Steel Plate Work, Etc.
Write for Catalogue

HEINE BOILERS

The Heine longitudinal drum water tube boiler, the Heine cross drum water tube boiler, and the Heine superheater, are fully explained in our catalogs, copies of which will gladly be sent on request.

203
HEINE SAFETY BOILER CO.
5318 Marcus Ave. St. Louis, Mo.

THE EDGE MOOR
WATER TUBE BOILER
Especially suitable for Large Power Plants

Steel construction throughout. Straight tubes. All hand-holes elliptical, their covers internal and removable through their own openings. Unrestricted circulation, permitting forcing of fires with safety and economy.

Send for Bulletins on Performance
EDGE MOOR IRON COMPANY
EDGE MOOR, DELAWARE
BOSTON NEW YORK CHARLOTTE, N. C. CHICAGO

NOT ONE Trouble-Making Feature is INCLUDED in the Design of this Boiler

The ERIE CITY VERTICAL WATER TUBE BOILERS

We consider labor-saving service next in importance to fuel-saving service, where economy in power production is a prime requisite. True economy in the boiler room is only where labor and upkeep costs are at a minimum. Even extensive fuel conservation must be complemented with labor-saving mediums to meet present-day demands for increased output with decreased operating costs.

Erie City Vertical Water Tube Boilers

provide for burning all kinds of fuel—coal, oil or gas—efficiently and economically. Our shops are among the largest and best equipped in the world, and the workmen therein, who create these boilers, are experts in boiler building.

Erie City Boilers are guaranteed to give the driest steam possible, containing less than one-half of one per cent of moisture, and to give it quickly and economically. The large horizontal drums permit a large liberating surface and steam holding storage capacity.

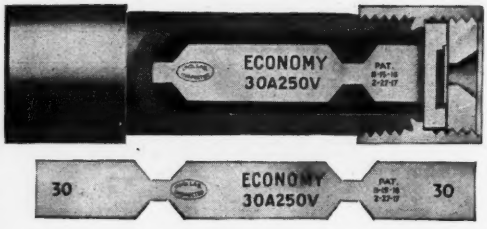
Each tube is a unit in itself—a factor conducive to rapid circulation and high overload capacity. Absence of hand-hole plates makes cleaning easy.

Space does not permit a more detailed description, but send for our latest literature and you'll soon see why Erie City Boilers are the standard in the world's most representative plants. Familiarize yourself with them and write today.

Erie City Iron Works
1510 East Ave. Erie, Pa., U. S. A.
Sales Engineers in the Principal Power Centers of the World.

The simplicity of the Erie City Vertical Water Tube Boiler is the foundation of the saving service it gives.

ERIE CITY IRON WORKS
1510 EAST AVE, ERIE, PA.



Ferrule Type Fuse with Economy "Drop Out" Renewal Link.

Progressive industries using electrical energy obtain more dependable protection to lives, property and machinery — at less cost — when they discard "one time" fuse equipment for

ECONOMY *renewable* FUSES

The famous Economy "Drop Out" Renewal link cuts annual fuse maintenance costs 80%.

It is the least expensive and the only portion destroyed when an Economy Fuse blows.

Economy "Drop Out" Renewal Links invariably operate at rated capacity. They are inexpensive—a reserve stock kept always on hand represents but a small investment.

The fuse itself—fibre cartridge, end caps and the winged washer which locks the link securely in place—is used again and again.

The merits of Economy Fuses have been recognized officially, for they were the first line using inexpensive bare renewal links for restoring blown fuses to their original efficiency to be approved in all capacities by the Underwriters' Laboratories.

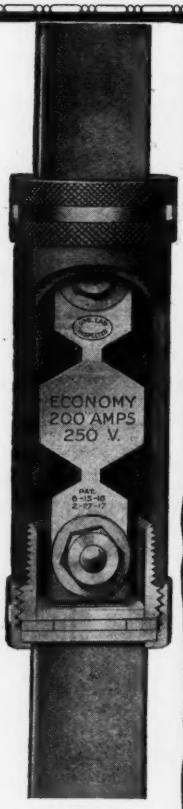
Your plant needs Economy Fuses.

For sale by all leading electrical jobbers and dealers.

Economy Fuse & Mfg. Co.

Chicago U. S. A.

Also made in Canada at Montreal.



Knife Blade Type, Economy Fuse

COOPER GAS ENGINES

Cooper Gas Engines are built in standard sizes of 150, 300, 485, 650, 970 and 1300 b.h.p. units for the most severe service where continuous operation is necessary.

MADE AS WELL AS THEY CAN BE MADE WITH THE EXPERIENCE OF EIGHTY EIGHT YEARS

The C&G COOPER CO.

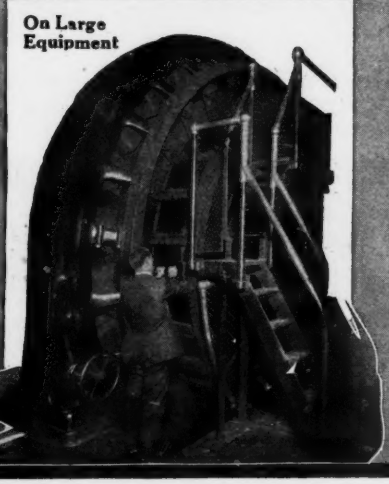
MT. VERNON, OHIO

Since 1833 Engineers and Builders

A Few Minutes Work Makes Commutation Perfect

Sparking and loss of power at your commutators and collector rings can easily and quickly be eliminated at small cost by applying the—

IDEAL COMMUTATOR RESURFACER



It is a manufactured abrasive block which when held against a revolving commutator, rapidly cuts down high mica and high bars and levels off flat spots. The IDEAL has a cutting surface which is always uniform and never fills with copper dust.

Avoids Costly Maintenance

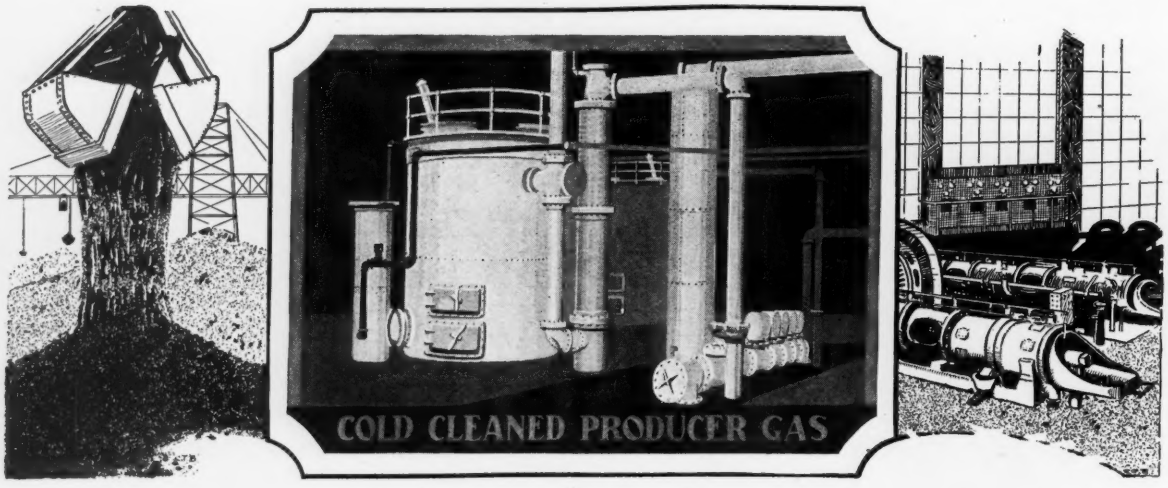
Having an IDEAL at hand and using it occasionally at the first sign of sparking, avoids costly commutation troubles.

Try One at Our Risk—MAIL THE COUPON

IDEAL COMMUTATOR DRESSER CO., PPE 12 15-20
3233 No. Sheffield Avenue, Chicago

Gentlemen:—Please send me an Ideal Commutator Resurfacer for free trial. If I am not fully satisfied with it I will return it collect at no expense to me. I want to use it on equipment as follows:

Approx. R. P. M..... Diameter of Commutator or Ring.....
Approx. width of Commutator or ring surface .....
Approx. distance between brush sets..... Condition.....
Ring material (copper, steel, etc.)..... .....
My name is..... .....Position..... .....
Company.....Company address..... .....
City..... State..... .....



Steam Power or Gas Power—Which?

Cost comparisons prove gas power so much more economical than steam power that its superiority in this respect cannot be questioned. "Why then," many power users ask, "do small plants continue to install steam equipment?" Here's the answer: Steam is established by over a century of use. No engineer questions its dependability or flexibility. A more satisfactory form of power could not be desired. But a more ECONOMICAL source of power SHOULD be demanded by many plants, and CAN be had.

Cold Cleaned Producer Gas For Power

Producer gas, made ideal for gas engine use by cooling and cleaning in Smith Producer plants, provides plants large and small with a source of power that costs little more than half as much as it would cost the largest turbine plant. Is this low-cost power dependable? Smith gas power plants where fires have not been drawn for several years, where maintenance is extremely low, where working conditions compare favorably with any steam plant, prove that the one objection ever raised to the gas power plant is not based on present-day facts.

Learn why America is rapidly awaking to the great economy of producer gas power—by writing for Smith Bulletins.

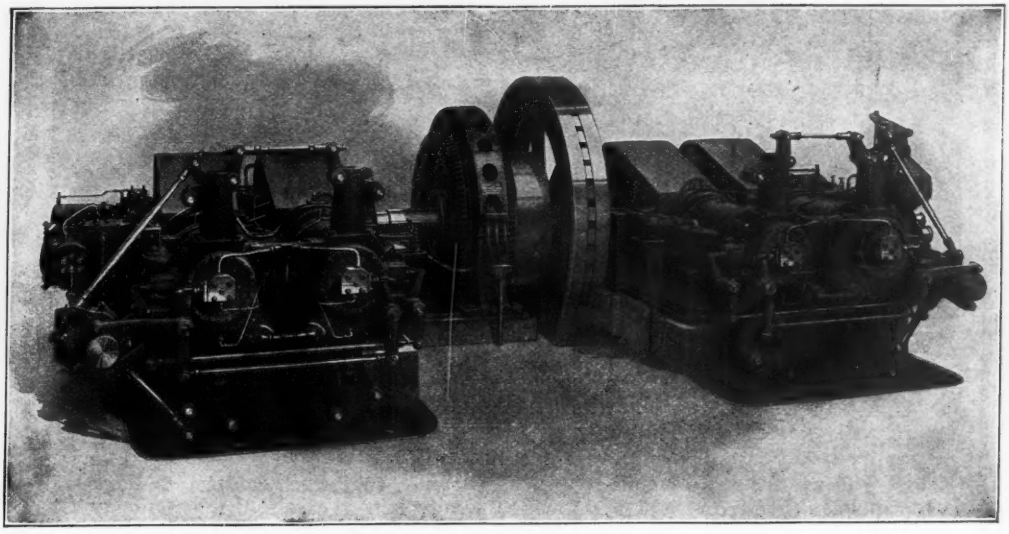
The Smith Gas Engineering Co., Dayton, Ohio

Factories: Dayton, Ohio, and Lexington, Ohio.
Sole Canadian Representatives: The Canadian Allis-Chalmers Company, Ltd., Toronto.

SMITH

The Low Cost Route From Coal to Power

GAS PRODUCERS



Allis-Chalmers Twin Duplex Oil Engine direct connected to an Allis-Chalmers Generator

Any Fuel Oil that can be Pumped will Drive an Allis-Chalmers Diesel

The open nozzle and the self scavenging feature of the horizontal type permit the successful use of any fuel oil that can be pumped, including oils that require preheating to make them flow readily through the piping. Oils such as Texas, Mexican and California natural crudes, some of which cannot be used satisfactorily under boilers, are easily handled in this engine due to the above features. The choice between the fuel oils available is therefore determined solely by the relative cost, heat value and convenience in handling.

The Allis-Chalmers Oil Engine is offered in sizes from 70 to 600 h. p., in one, two, three, four and six cylinder units, making a full line of sizes and cylinder arrangements for any condition of service for which gas or steam engines are suitable.

We will be pleased to receive your request for Bulletin 1532-C.

ALLIS-CHALMERS MANUFACTURING COMPANY

Milwaukee, Wisconsin, U. S. A.

District Offices in All Leading Cities

ALLIS-CHALMERS PRODUCTS

Electrical Machinery
Steam Turbines - Steam Engines
Gas and Oil Engines
Hydraulic Turbines
Crushing and Cement Machinery
Mining Machinery
Flour and Saw Mill Machinery
Power Transmission Machinery
Pumping Engines - Centrifugal Pumps
Steam and Electric Hoists
Air Compressors - Air Brakes
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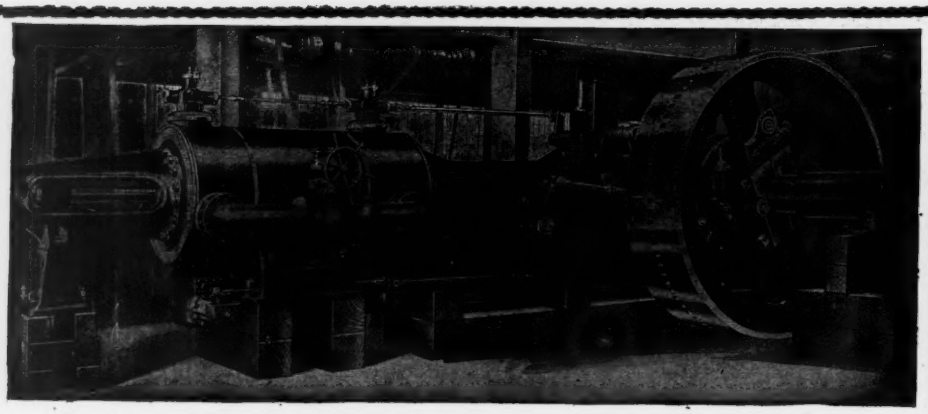

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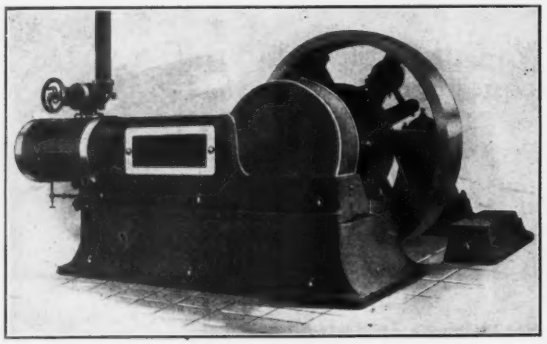

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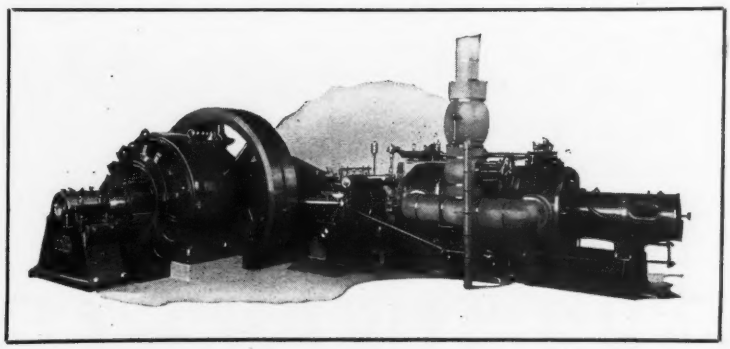

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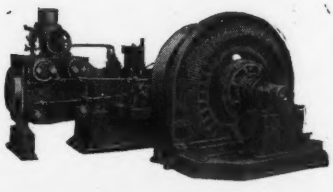

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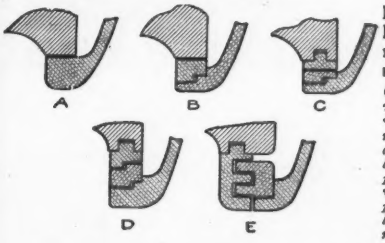

Evolution of the De Laval labyrinth wearing ring

(a) plain flat joint without renewable ring; (b) wearing rings on impeller only; (c) rings on both casing and impeller; (d) offset wearing ring; (e) perfected De Laval labyrinth wearing ring.

THE superiority of the **De Laval Labyrinth Wearing Ring for centrifugal pumps** over plain flat or offset rings is due to the following facts:

It lasts much longer with bad water than will flat rings for equivalent leakage.

Two rings are provided, one for the impeller and one for the casing, hence both impeller and casing are protected from wear at this point and last indefinitely.

The DeLaval rings are made to limit gages on an interchangeable basis, and are easily and quickly renewed, no fitting being required.

It does not require small clearances in order to prevent excessive leakage. Large clearances are possible both axially and radially, as the many abrupt turns in the leakage path and the greater length of path reduces the leakage, as compared with flat rings.

The leakage between the impeller and the casing has great influence upon the efficiency, and is ordinarily not detected even when excessive.

The efficiency and other characteristics of each DeLaval pump are guaranteed, and the guarantee is confirmed by a test on the pump at the shop. The use of labyrinth wearing rings insures long maintenance of the original efficiency, and the ease of renewing the rings makes it possible to bring the pump back to its original efficiency after long use.

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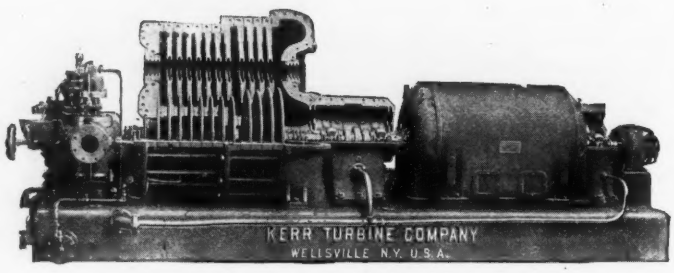
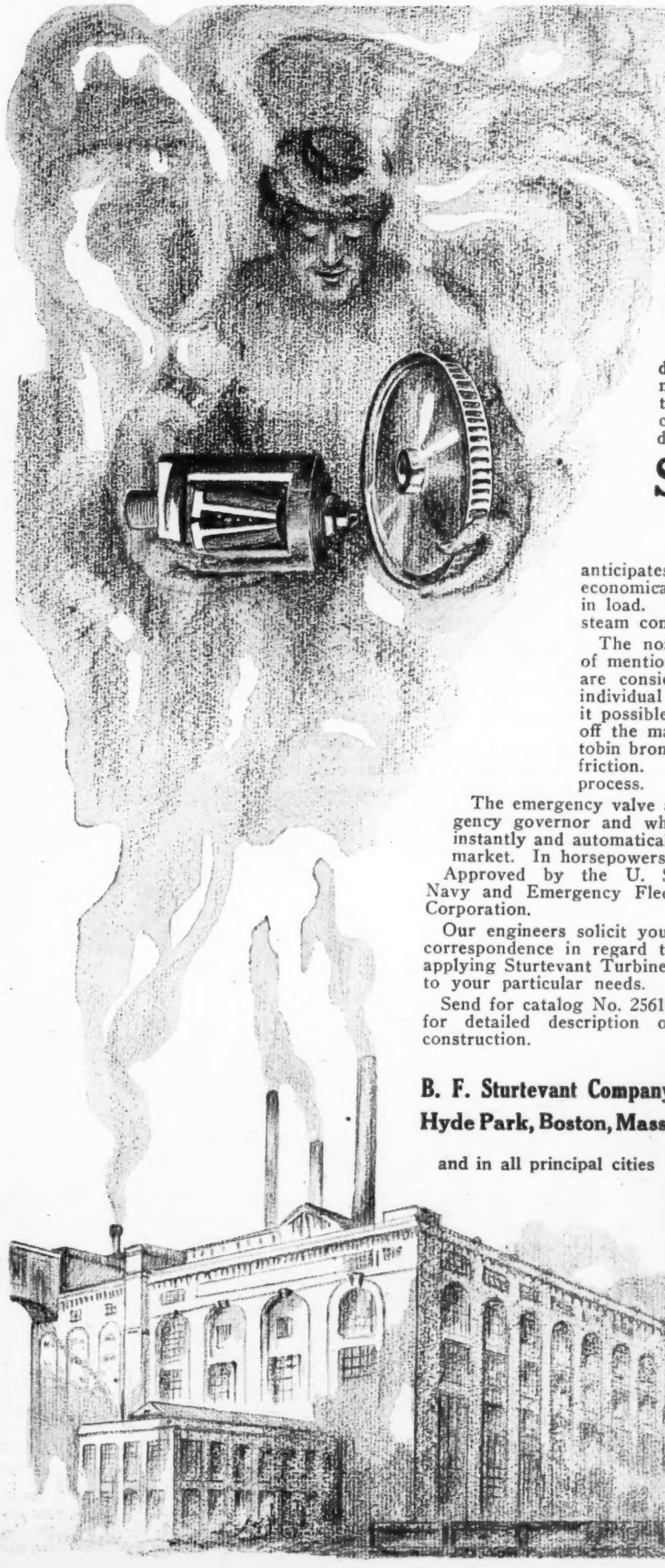


Economy

Steam Turbines



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Anticipate New Demands for Economy

Demands made today of turbines designed for **driving fans, blowers,** generators and pumps are more exacting than ever before, consequently turbines built to meet requirements of the past, cannot compete with those built for modern conditions.

Sturtevant Type 10 Turbine

anticipates these ever changing requirements and gives economical and dependable service regardless of the range in load. Continuous operation is assured with minimum steam consumption.

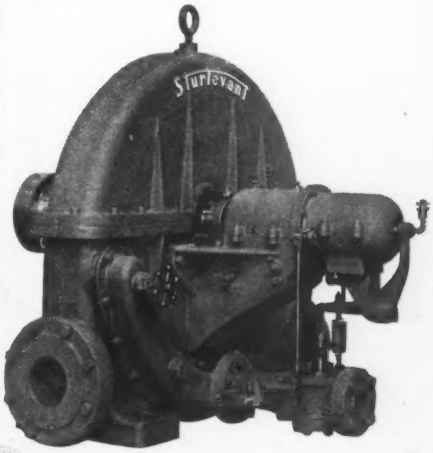
The nozzles and reverse buckets are features worthy of mention when the advantages of Sturtevant Turbines are considered. By simply closing a hand valve each individual nozzle can be cut out of service. This makes it possible for light loads to be carried without shutting off the main steam supply. The buckets are made from tobin bronze, carefully fitted and polished to reduce steam friction. Milled into the rim by our own patented process.

The emergency valve assures reliability. It is connected to an emergency governor and when a predetermined speed is exceeded, closes instantly and automatically. This turbine has been twelve years on the market. In horsepowers from one to five hundred.

Approved by the U. S. Navy and Emergency Fleet Corporation.

Our engineers solicit your correspondence in regard to applying Sturtevant Turbines to your particular needs.

Send for catalog No. 25610 for detailed description of construction.



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MACHINERY

Steam Engines
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Condensers

SMOOTH RUNNING

The illustration below shows a 15"x24" Nordberg-Todd Uniflow Poppet Valve Engine in an eastern chemical plant. Note the sharpness of detail, although the engine was photographed while operating at normal speed.

Owing to unique features of design, Nordberg-Todd Uniflow Poppet Valve Engines operate with extreme quietness and absence of vibration, resulting in a remarkable absence of repairs and costly shutdowns.

Next to low maintenance cost, economy of fuel is often of primary importance, hence the ability to maintain a lower steam consumption, over wider variations in load, than any other form of steam prime mover gives additional preference to the Nordberg-Todd Uniflow Poppet Valve Engine.

The engineering advice of the Nordberg organization is gladly extended to plant executives and city officials who wish to effect sustained power plant economies—just write.

NORDBERG
MFG. CO.
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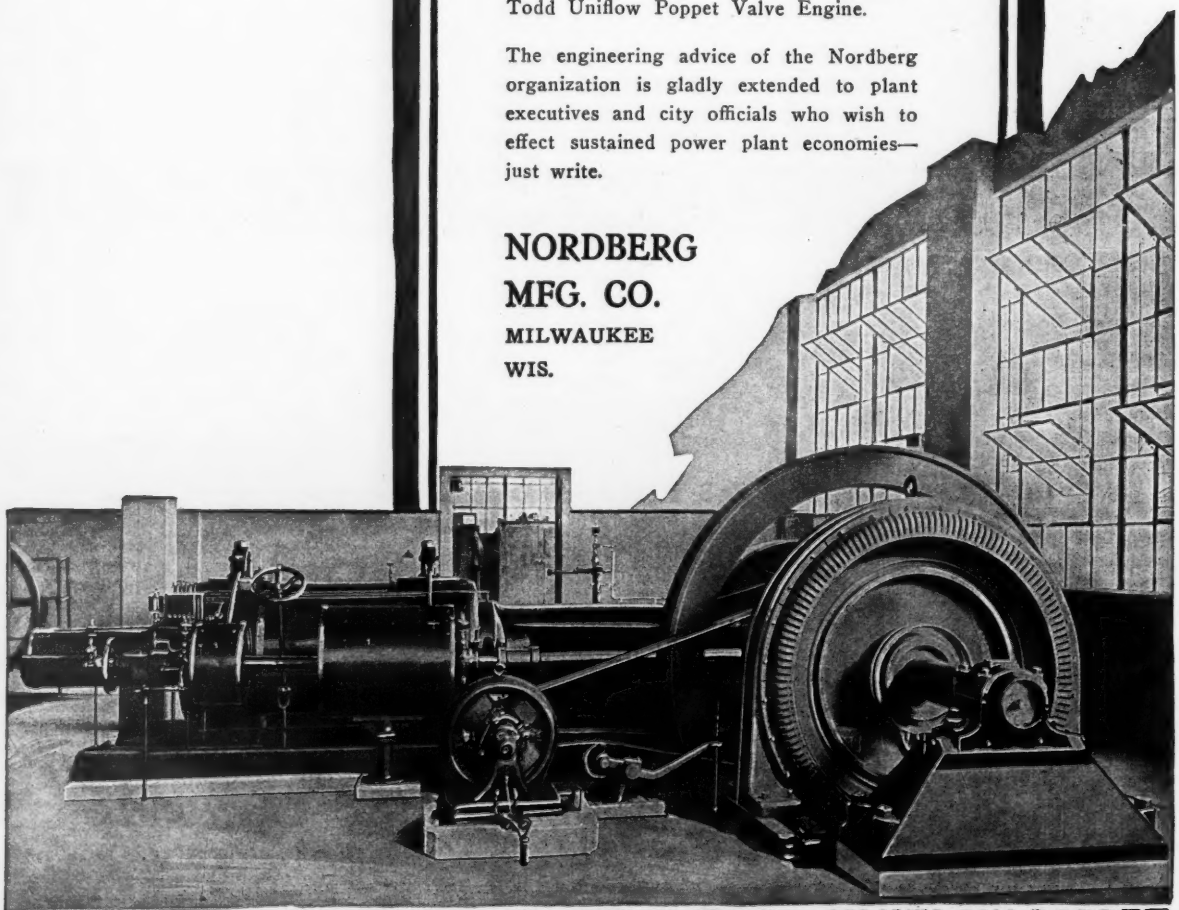
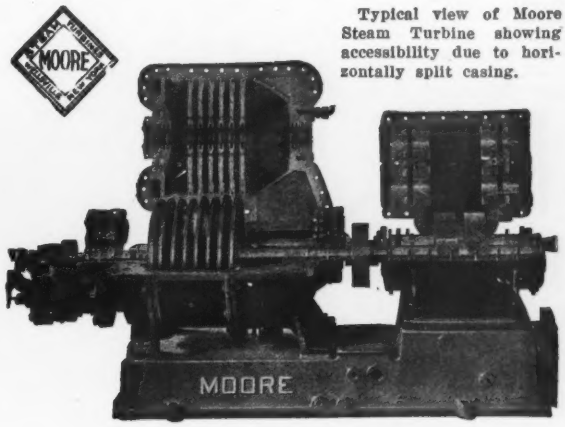


NORDBERG-TODD UNIFLOW POPPET VALVE ENGINES

Saving Fuel and Money In Up-to-Date Plants

MOORE

STEAM Single or Multi-Stage TURBINES



Typical view of Moore Steam Turbine showing accessibility due to horizontally split casing.

So positive is the steam economy of Moore Turbine operation that hundreds of the country's greatest industrial plants have already adopted them as the most perfect defense against coal shortage.

Such prominent concerns as Brooklyn Edison Co., Massachusetts Metropolitan Water Board, Goodyear Tire & Rubber Co., Philadelphia Electric Co. and Carnegie Steel Co. have achieved savings in time and labor as well as fuel by enlisting Moore co-operation.

Moore Turbines have won the reputation for superiority by their maintained high steam economy over wide range of load; their safe speeds, efficient lubrication, low upkeep costs and long life.

Moore Turbines are built in sizes from 5 to 1000 h.p.

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Moore Steam Turbine Corporation, Wellsville, N. Y.

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